INJURIES OF THE WRIST

INJURIES
OF THE WRIST
A RADIOLOGICAL STUDY

BY THE LATE
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PREFACE

Destot's work on the injuries of the wrist ought to have appeared a very long time since. Circumstances over which we had no control have delayed its publication.

The treatise, begun in 1897, was only finished by Destot in 1918, shortly before his death. It describes the results of his researches and of his experience.

We have confined ourselves to publishing the manuscript which Madame Destot has kindly entrusted to us, according to the wishes of the master.

This humble task, which we have gladly undertaken, has given us a new opportunity of bearing witness to our affectionate remembrance of the master.

<div align="right">
Aigrot,
Bosquette,
Gallois,
Japiot.
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CONTENTS

LIST OF ILLUSTRATIONS

7

INTRODUCTION

SINCE the appearance of my small book on " le Poignet et
les Accidents du travail," the study of injuries of the carpus
has been the subject of numerous works, and I have
thought, notwithstanding the success of this small mono-
graph, to which the Academy was kind enough to award a
prize, it would be a good thing to treat in a larger way the
history of lesions of this region, quoting my own personal
experiences. In spite of all the criticisms and all the
controversies, I have not in any way changed my first
opinions, because, having begun my studies in 1896, I had
no desire to produce the whole work before 1905 : my book
at that time represented the results of an experience of
nine years : this one, like the former, being based on ob-
served facts, will only serve to make these first data com-
plete. Search after truth has always been my guide, and
perhaps for that reason the views expressed have appeared
original. It is difficult to divorce oneself from the ideas
of others, but the opinions stated are my own. Precious
time is lost by clearing the brain of previous formulæ,
acquired laboriously and so often accepted without verifica-
tion. Perhaps it will be of interest to know by what way
I have been led to concern myself especially with the
subject of injuries of the wrist, and what originated my
researches.

Each time a new and certain means of experimental
analysis arises, science is always seen to progress in relation
to the questions to which this method can be applied,
said Cl. Bernard in his Introduction to the study of
experimental medicine, and this truth shines forth in all
branches of medicine whenever new methods of investiga-
tion allow of the amplification of purely personal clinical
data by precise physical means, and of the substitution of
the sensation of sight, the delicacy and extent of which is
much greater for those of touch and of hearing.

To continue. ever since Röntgen's discovery, I had been
enthusiastic about this new method, and by February, 1896,
I was equipped with all the necessary apparatus. As it hap-
pened, my attention was first directed to the foot, but in
November of the same year it was drawn to the wrist, of

which, like my coadjutors, I thought I knew everything, but I immediately discovered it was not so.

I had come to Paris to buy some Crookes's tubes at the establishment of Chabaud, the famous maker, who lived in the Rue de la Sorbonne. He was then the only French manufacturer, and there was a long wait for one of his ampoules. Seeing in the front of the building a superb cast of a hand, I entered and asked the author's name: it was the Marquis de V—— Rentré of Lyons : I wrote and congratulated him on his skill and enquired regarding the history of the injury, which I considered was due to his slipping and falling, the feet shooting out in front, and the body falling backwards, the hands resting on the ground to lessen the shock, an opinion corroborated by the Marquis who came to me two days later.

He had fallen three years since, whilst skating at the Brenets, in the way above described, and since that time he had, on certain movements, pain and uneasiness in his wrist.

It was the first fracture of the scaphoid I had had the opportunity of seeing. From that time searching in the immense storehouse of the Hôtel Dieu at Lyons, for all the injured wrists, I noticed the different and peculiar appearances of the scaphoid in fractures of the radius. Naturally all kinds of injuries of the wrist came under my consideration, although there was an epidemic of fractures of the scaphoid which raged until February, 1897. At this time I submitted for operation to my friend and master Vallois, an anchylosed wrist, which presented a pseudo-fracture of the scaphoid. The operation showed me my mistake : it was the first dislocation of the carpus in which Vallois attempted surgical reduction.

From that time I possessed two facts which showed that the carpal condyle[1] played a rôle in cases of injuries, since it changed its shape, and also that a small bone to which, up to now, no importance had been attached, could break. At the same time I found, although four years as assistant, my knowledge of anatomy did not enable me to read or interpret my plates. I therefore bribed the servants of the

[1] The first row of the carpus ; see p. 40   (Translator.)

Faculty, and with the help of my old friends and pupils, Gallois, Briau and Denis, my room was transformed into a dissecting-room : every evening, Gallois, at that time prosector, brought all the available wrists from the University : they were broken, radiographed and dissected every time the plate showed a change in them. The next morning they were all taken back and put into their places, to avoid our theft being discovered.

Briau served as a model in front of the screen for the study of the physiology of the wrist, and placed at my disposal his drawing-pen. At the same time all the injuries, it mattered not what, of the wrist which entered the Hôtel Dieu were conscripted, so that in a short time I could read and interpret the radiograms. These old memories of seventeen years show at that time the knowledge believed to exist regarding the wrist was quite rudimentary. My old master, M. Pollosson, who as chief surgeon chose the subject for the prize at the end of the year of house-surgeoncy (Bouchut's prize), was very surprised when I asked him to select as the theme in 1898, fracture of the lower extremity of the radius, which he believed was perfectly well known.

Gallois was prizeman, and his thesis showed the rôle of the carpal condyle in fractures of the radius, the method of production of the swelling on the back of the hand, and the experimental conditions necessary for isolated fracture of the scaphoid. This enormous work included experimental examination of all the pathogenic theories invoked to explain fracture of the radius.

On August, 1898, I came across my first recent dislocation of the carpus in a student of medicine, and M. Goullioud reduced it. This lesion which I had met with and failed to recognise in February, 1897, and had been able to observe in some old cases and on which Vallois had tried partial resections without a satisfactory result, had become familiar to me. I had published 3 cases in the " Province Médicale " of 1898, under the name of mid-carpal luxation. Tavernier, in his thesis in 1906, collected 24 cases in Lyons. Since then, my own observations number 90. My cases of fracture of the scaphoid have at the same time multiplied.

In Reynard's thesis, I collected all my cases up to that time, and since then my number amounts to more than 150. Fractures of the semilunar are much rarer (24 cases). Lastly, the less marked and less characteristic lesions of subluxation of the scaphoid and of the semilunar, a dislocation met with in nearly half the cases of fracture of the radius, have permitted me to-day to collect a whole series of conditions due to injuries of the carpus, hardly mentioned in classical treatises.

Fractures of the os magnum (4 cases), of the cuneiform (6 cases) and of the trapezium (4 cases) are only of slight importance, because of their rarity, and one of my objects is to show what strong physiological connection binds fractures of the radius to these different bones and why and how the scaphoid and the semilunar bear the brunt of injuries.

Between sprain, dislocation of the scaphoid and of the semilunar, dislocation of the carpus, fractures of the scaphoid alone or associated with fractures of the radius and of the semilunar, it is only a difference of degree and of anatomical variations, which depend on the points of application of the force, according to the different position in falling.

We are forced, for purposes of description, to isolate prominent groups from any scheme of classification, but they arise from the same chain and are connected by the links which lead from one to the other.

This general conception binding all the lesions of the scaphoid and of the semilunar has resulted from my anatomical researches, which were only undertaken to explain facts which appeared discordant and are considered in Cousin's thesis (1897). In the main, when the pathological physiology of the wrist is understood, all the facts become easily connected, whereas every hypothesis, however ingenious, ends inevitably in erroneous conclusions, if clinical facts be not sufficiently considered. The best criticism which can be made regarding M. Delbet's theory of 1906, which he supported by invoking the aid of the ligaments, is the incorrectness of the conclusion in which he denies the possibility of reduction of the semilunar.

The facts are that all the recent cases which have been kindly entrusted to me since 1898 have been reduced even at the end of twenty-five days, and in one case after three and a half months.

Independently of the scientific interest of this question, there is the possibility of very rapidly bringing back to the injured person the use of his hand which, if left to itself or operated upon later, often remains. greatly incapacited This practical knowledge, unhappily, is still not generally known, since in Paris, this very year, I have been asked to assess some unrecognised cases.

When Tavernier, on my advice and that of Vallois, wrote his beautiful thesis in 1906, a study of the 24 cases from my collection enabled him to formulate strong conclusions regarding reduction, and the different surgical operations.

Jaboulay extirpated the semilunar by the anterior route in 1901, a method which naturally suggested itself. Vallas, in 1897, tried reduction by operation, and then performed a number of partial resections, the bad results of which led him to prefer complete resection in old cases. There existed, then, a whole mass of researches and experiences dating back to February, 1897.

The first case in Eigenbrodt's memoir published in 1901, dated from September, 1897. The work of Lessev (1902), that of Gross (1903) and lastly that of Lilienfeld, who succeeded in producing dislocation experimentally goes back to 1905. Gallois and I experimented on more than 100 subjects without producing anything but different types of fracture of the radius, and fracture of the scaphoid alone.

It is not absolutely true to say, as Tavernier does, this question had not been studied in France, whilst large memoirs existed in foreign countries since 1901. I presented to the Societies in Lyons sufficient facts and enough of the physiology of the wrist for Tavernier himself only to have to consider and compare them with foreign works to show that my researches borrowed nothing from them ; but these first observations were not accepted without difficulties, and the indifference shown by modern surgeons for fractures benefited me.

For twenty-five years the victory of asepsis has broken down all surgical barriers, and all efforts have been concentrated on new paths. Fractures and dislocations have been neglected, and if the law of 1898, regarding occupational accidents, have given them a little lustre, they have only come into their own to-day because surgical boldness does not hesitate now to upset the old treatment, and to substitute for it operative methods.

Formerly, open fractures were feared ; to-day those which are not compound are made so. Fractures have benefited by current views, which need not be discussed. I will simply note that for many years, when I had every facility for systematic observation, only a few French surgeons showed any interest. It was not till 1906 that the memoir of Delbet and the thesis of Née attracted the attention of French surgeons, whereas foreign countries already possessed the observations of von Lesser (1902), Gross (1903), Lilienfeld (1905), Eigenbrodt (1901), Kauffmann (1903), Höfliger (1901), Codman and Melville Chase (1905). But at that date I had already gathered in a large harvest of facts.

It is not without interest to cast a retrospective glance along the road travelled, and to balance up all that was known before radiography of the subject under consideration, in order to compare it with the present state of our knowledge.

From Hippocrates to Pouteau, fractures of the lower end of the radius were considered as radio-carpal dislocations, of which four varieties were described : anterior, posterior, internal and external. In the posthumous works of Pouteau, published in 1783, thirty years before the memoir of Colles (1813), fracture of the lower end of the radius is admirably described, accompanied naturally by a wrong theory on the action of muscular contraction. In spite of Pouteau's discovery, the views of Hippocrates were in the ascendant when, in 1820, Dupuytren boldly attacked the sacred ark. He showed in all articular fractures of the foot, as well as in those of the wrist, fracture preceded dislocation, and his teaching was new.

Without absolutely denying the possibility of posterior

dislocation of the radio-carpal joint, although I have never met with it, at least it must be admitted it is excessively rare, perhaps never occurs as the result of a fall on the anterior part of the wrist. The cases of posterior luxation of the carpus only on the forearm, described as such by authors, were probably only fractures of the radius situated a quarter, a half, or even a thumb's-breadth from the lower end, or simultaneous fractures at the same point of the radius and of the ulna.

The discussions of Dupuytren with Pelletier at the Hôtel Dieu, and with Marjolin at Beaujon, and the great fame of his clinical lectures both in France and in foreign countries, ended in luxations disappearing from the scene, and the fanatical partisans of Dupuytren went beyond his opinion. All observations on luxation were denied. Dupuytren had said it was rare, his pupils declared it to be impossible. But a reaction set in. Letenneur showed at the Anatomical Society a case of dislocation of the wrist, Molle reported an observation with autopsy (1838). Later, cases were described by Marjolin, and by Voillemier (1839), by Taylor (1840), Scoubetten (1841), Barker (1845), Pollosson (1845), Dupuy (1850), Paul (1851), Chassaignac (1857). The cases of Kelly and of Laloy and Huguier were described in 1859. In 1861 Jarjavay showed a specimen, and Benjamin Auger (1865), Guyon (1868), Eloy (1873) and Chapplain (1874) each met with cases. In 1878, Howard Lowe reported an autopsy, in which he had noted anterior displacement of the semilunar and of the scaphoid. In 1880 Servin described incomplete dislocation of the carpus. In 1890 Curtillet, and in 1892 Gaudier, drew attention to a case.

The experimental school substituted for pure and simple observation, and for pathological anatomy, what was found to be impossible to produce on the cadaver. Bouchut, experimenting under Dupuytren's inspiration, could only produce fractures, and all surgeons thinking themselves mechanics discussed direct transmission and transmission by means of the interosseous ligament, each one explaining the swelling on the back of the hand according to his own view.

Pouteau's theory on muscular contraction had been abandoned, and Bouchut's theory of " arrachement " had gained more and more partisans.

Naturally, the carpus played no part, and since luxations could not be produced, it was only a step to consider their existence impossible, a biassed opinion, not indeed peculiar to the older observers ; Tavernier in his thesis also excluded mid-carpal luxations, and posterior displacements of the semilunar.

Abadie, in his thesis, had however referred to 71 cases of radio-carpal dislocation prior to radiography, and if after a first sifting some doubtful cases can still be found, at least the facts he reported cannot be denied. Four cases of mid-carpal dislocation certainly exist : those of Maisonneuve, Richemond, Després and Claudot. On the other hand, incomplete luxations were known, as the case of Howard Lowe, and that of Servin, which he interpreted as a radio-carpal luxation, save for the semilunar.

On probing into the literature, some examples of lesions can be found which, since radiography, have been studied systematically, but before 1896 they were considered curiosities of no importance and of no practical value. Albertin, having come across two cases of enucleation of the semilunar through the skin of the wrist, collected with difficulty two or three others, and although Howard Lowe had seen a dislocation of the carpus in 1878, it would never have been anticipated that a single observer would one day muster 90 personal cases.

It had not occurred to Bouilly in 1894 to look for the cause of the gravity of some fractures of the radius in lesions of the carpus, for the simple reason that experimental researches had produced wrong conceptions. Experiment, because it seemed to be pseudo-scientific, was given the first place instead of being looked upon as a method of verifying clinical observation, as Amedée Bonnet did, and of producing certain results from injuries. Hence, the endless theories to which authors are proud to give their names permanently.

There were, however, added other forms to the primary type of fracture associated with the name of Pouteau.

Cracks and fissures were seen close to the epiphysis. Hutchinson had described fractures of one and of both styloid processes, Bennett fracture of the sigmoid cavity, Rhea Barton posterior and Letenneur anterior marginal fractures.

Radio-carpal dislocations were exceptional. They are so always, and I have seen only one case.

Four authentic mid-carpal luxations, some isolated fractures of the unciform and of the os magnum, four enucleations of the semilunar, and two luxations of the scaphoid : that was all.

But to-day the part played by the carpal condyle in fractures of the wrist is no longer doubtful, as is shown by some new varieties of fracture of the lower end of the radius. Isolated fractures or fractures associated with the scaphoid are common, dislocations of the carpus are frequent, mid-carpal dislocations more rare, but fractures of the semilunar more numerous, since I can count 24 cases. But all these isolated or associated lesions of the carpus form a complex whole that must be analysed in order to group the cases according to their nosology, and it is here verbal difficulties arise, and I ought in these preliminary remarks to explain the terminology I employ and have chosen, for a similar affection bears many names.

It is a very difficult question how to classify and label lesions so complex as those of the wrist.

If common sense in clinical matters only governed the classification, everything would be easy.

Unfortunately there are rules, tradition, academic questions and systematisation, and then the simplest things become complicated. Classification of fractures has been based on their presumed method of production, in which experiment and theory have played a part. Some practical but narrow minds have required as a certain basis pathological anatomy, a firm foundation it is true, but the fearful complexity of these cases renders this method inapplicable, for nearly every case differs from each other in small points, and if a class were made for each of them it would end in a hotch-potch.

B

Nowhere, perhaps, does the weakness of the system employed appear more obvious than in the wrist, and the necessity for a general guide, drawn from pathological physiology and from clinical examination, is obvious.

It is easy to give a concrete example :

A person falls down and suffers from an injury to the wrist, radiography showing the following conditions :

(1) In the forearm, fractures of both styloid processes :

(2) In the carpus :

    (*a*) Fracture of the scaphoid, the upper fragment of which is enucleated to the palmar side, whilst the lower tilted fragment is prominent in the anatomical snuff-box.

    (*b*) Displacement of the semilunar which has lost its connections : (1) with the os magnum : (2) with the glenoid cavity of the radius ; (3) with the cuneiform ; (4) with the fragment of the scaphoid united to the trapezium. The semilunar suspended by its anterior horn is prominent in the palm, where it causes nervous symptoms from compression.

The os magnum, on the contrary, having preserved its connections with the trapezium, trapezoid and unciform, and the latter with the cuneiform, protrudes slightly on the dorsal surface of the wrist, and is most often found in the prolongation of the axis of the forearm. These are the bare facts. What shall this complex lesion be called ?

At once, say some, the fracture predominates, and consequently the fractures of the styloid processes and of the scaphoid overrule the luxation. The old luxations of Hippocrates have here become fractures of the radius, since the time of Pouteau and of Dupuytren. They are certainly dislocations, but they can only be considered such if the bones of the forearm be intact. In the same way, in the foot, the tibio-tarsal luxations have yielded the prior place to fractures of the malleoli. But is this the case here, and can it be maintained luxation of the semilunar has, as a necessary condition, fracture of the scaphoid and of the

styloid processes ? No, certainly not, because in cases similar, clinically, these fractures are not met with : the scaphoid can be dislocated, either anteriorly, which is rare, or posteriorly, without breaking, and fracture of the styloid processes is only a fortuitous accompaniment. These lesions are, therefore, accessory, as the study of a series of cases shows.

Hence, the fracture has not here the importance it acquires in other articular injuries, where the eternal discussion, to wit, if it be a fracture with dislocation or a dislocation with a fracture, easily settles itself, as in the ankle, for instance, where Malgaigne and Maisonneuve have shown by facts, fracture preceded luxation, which was secondary.

We admit that in this case dislocation is predominant, but which luxation ?

The name, said Malgaigne, of the distal fragment is given to dislocation. Consequently, the case related should be described : dorsal luxation of the os magnum with fracture of the scaphoid and of the styloid processes. This is correct if we admit all joints are the same.

To begin with, we must note how peculiar is the luxation of the os magnum. All the bones of the carpus are connected to each other, excepting the scaphoid and the semilunar, and these two bones have lost their attachments to each other and to the glenoid cavity of the radius. We have, therefore, to do with an incomplete mid-carpal dislocation. Why give it the name of the os magnum only, seeing it is accompanied by its satellites ?

Looked at, indeed, from the point of view of the semilunar, we see this bone has lost its connections with the radius and with the carpus and, in some cases also, it even protrudes through the skin. Shall Albertin's cases, for example, be called dorsal luxations of the os magnum, or mid-carpal dislocations ? This is contrary to all common sense, and only systematisation conduces to such absurdities. No, classification cannot be based on pathological anatomy alone, or on ordinary nomenclature, the principles of which are in the above cases faulty, and we must have recourse to physiological facts.

The foot and the hand are connected with the leg and the forearm by the astragalus, and the scaphoid, and the semilunar respectively, and the same terminology cannot be applied to lesions of these parts as to luxations of the leg and forearm owing to the intermediate structures between the two articulations.

In the wrist the scapho-lunary system is an intermediate joint which doubles the amplitude of the movements of the hand, adding to the displacements of the radio-carpal and mid-carpal joints and transmitting to the second row the shocks it receives from the forearm. The scaphoid and the semilunar are wedged between the malleus of the forearm and the incus of the second row united to the metacarpus, and according to the numerous positions on falling, the amount of violence, and numbers of different conditions, will show special lesions. The best proof that can be given of the importance of the scaphoid and of the semilunar is the frequency of their lesions. Take a thousand cases of injury to the wrist, either fractures of the radius, lesions of the carpus, or mixed lesions, and it can always be said the scaphoid and the semilunar play a part. How are the lesions of the other bones to be described : the cuneiform, os magnum, trapezium or unciform ? Exceptions of no importance. If, then, clinically the lesions be centred in the scaphoid and in the semilunar, it is because these two bones from their physiological action obtain especial importance, and pathology confirms their entity. The discussion on the foot between Malgaigne and Broca, regarding the rôle of the astragalus, is applicable to the hand, and I attribute so much value to the scapho-lunary system that, in spite of all criticisms, I shall continue to speak of dislocation of the carpus in order to show that the different luxation of the scaphoid and of the semilunar met with in the majority of the plates of so-called dorsal luxation of the os magnum is the dominating factor, as demonstrated by my pathological study dating back to 1898, and hence my new name for the new facts, new, because the observations prior to radiography are not of any value, because they were isolated and disconnected ones and the cases were not methodically studied.

Tavernier in his thesis has not ventured to throw in his lot with any side, and is satisfied with the vague term, displacements of the semilunar, as if the scapho-lunary system played no part. This is an error ; the major bones of the first row cannot be separated, and I hope to show how close are the ties uniting the two bones in affections of the carpus.

When we speak, for example, of isolated fractures of the semilunar, we ought to add with sub-luxation of fracture of the scaphoid, or even fracture of the radius. The carpal condyle cannot be flattened or diminished in height in the region of the semilunar without bringing in its train a diminution in the height of the column of the scaphoid, and the latter must dislocate, break or become impacted in the radius to compensate for crushing of the semilunar, in the same way, as when the scaphoid is crushed, the semilunar must be dislocated or be broken.

Is the semilunar exposed to the injury as a result of the fracture of the scaphoid ? or is it the reverse ? Usually the lesion is simultaneous, sometimes the semilunar, sometimes the scaphoidal lesion has been primary : the study of these so-called isolated cases shows it. But whatever may be the method of action of the force, the lesions of both bones are inseparable. There arises from this long discussion to which I should not have committed myself, if from it practical hints did not emanate, that injuries to the carpus present a special appearance, and their study is intimately connected with the physiology of the wrist. Anatomo-pathological classifications only cannot be applied, because they take no account of the subordination of one of the existing lesions to the other, and, in addition, the enormous multiplicity of the classes they bring in their train does not give a proper estimation of the lesions. Every correct classification ought to rest on clinical observation, and pathological physiology ought to occupy the first place, but it is difficult to do so, but directly it is accomplished everything becomes clear, and, as a result, treatment finds its best indication.

What constitutes the enormous difficulty in classifying affections of the wrist, is the contrast between the facts

obtained from clinical examination only, and the frightful complexity of the lesions as revealed by radiography, so that if clinical types be adopted, each of them is seen to hide a certain number of different lesions : if, on the contrary, we take our stand on pathological anatomy, we become overwhelmed by numerous details.

There are only three or four clinical classes, but we must still have recourse to them, well knowing the same symptoms correspond to different lesions.

The lesions ought to be classified from a purely functional point of view, and here physiology comes into its own.

We shall describe, first, sprains, then dislocation of the carpus, and, in addition, mid-carpal luxation, and then fractures of the carpus. These concern the carpus.

In the second place, we shall have to study, from the radial side, complete and partial fractures of the lower end, intra- and extra-articular, without or with displacement, isolated fracture of the lower extremity of the ulna and radio-carpal dislocation.

Under the mask of sprains, according to the classical definition, not only is there hidden temporary luxation with tearing of the ligaments and of the fibrous tissues, and hernia of the synovial membranes, but also subluxation of the scaphoid and of the semilunar, a true diastasis with permanent articular displacement, and the whole series of fractures of the scaphoid and also comminuted fractures without displacement of the lower extremity of the radius. The clinical study of sprains, analysed by radiography will then show a number of lesions, formerly unsuspected.

For instance, dislocation of the carpus has the same clinical appearance as fractures of the semilunar and mid-carpal luxation, but radio-carpal dislocations, which are very rare, resemble fractures of the lower extremity of the radius rather than carpal lesions.

Roughly speaking, we can separate carpal lesions from those of the forearm, as long as we bear in mind : (1) mixed cases, where lesions of the carpus and of the forearm are plainly associated, and there are found, at the same time, symptoms connected with both the carpus and with

the forearm ; (2) hidden lesions, radial complications with carpal lesions, or carpal complications with lesions of the radius, be they concealed from or revealed by radiography.

We will study :

1. The anatomy and the physiology.
2. Sprains and sub-luxation of the scaphoid and of the semilunar.
3. Fractures of the scaphoid.
4. Dislocation of the carpus, and, in addition, mid-carpal luxation.
5. Fractures of the semilunar.
6. Rare fractures of the other bones.
7. Radio-carpal luxation.
8. The different forms of fractures of the lower extremity of the radius.

The headings are sharply defined and differentiated, but they do not take account, from the anatomical point of view, of all the varieties ; they form, however, landmarks, and heads of chapters, which allow us to follow, without too great difficulty, the very extensive field of injuries of the wrist.

I hope this study will show the extensive knowledge we owe to the systematic application of radiography to injuries of the wrist.

E. D.

INJURIES OF THE WRIST

ANATOMY AND PHYSIOLOGY OF THE WRIST

LOOKED at entirely from a traumatic point of view, the anatomy of the wrist presents a certain number of very interesting points, which it is first necessary to recall if we wish to understand the lesions of this region.

I shall take for granted knowledge of the muscles, of their tendons, of the vessels and of the nerves. The bones and their ligaments will alone detain us.

I will study in turn :—

1. Its constitution, morphology and connections with the soft parts and with the skin, the foundation of clinical examination.
2. The radiographical anatomy, i.e. the method of normal projection of the bones, and their appearance on the plates, because reading a plate requires this knowledge to avoid error.
3. Lastly, the physiology, i.e. the positions the different constituent parts adopt in the attitudes taken up on falling.

I. WHAT MUST BE UNDERSTOOD REGARDING THE CONSTITUTION AND MORPHOLOGY.—The wrist is not limited to the carpus, it ought to include the inferior extremity of the forearm. Its line of demarcation is distinct below, viz. the carpo-metacarpal space, but above it is arbitrary : it is a horizontal line passing about 33 millimetres above the radio-carpal space. This upper limit has been fixed as the result of pathological and anatomical findings. Nearly all fractures of the lower extremity of the radius have their site between 6 and 25 millimetres above the carpus. Examination of 69 pieces in Dupuytren's museum, the collections of Poirier and of Ollier show two maxima, one at 10, and the other at 25 millimetres. But, we must take account of fractures, the upper extremity of whose line is often higher.

These pathological points allow us to limit the region to 33 millimetres above the radio-carpal joint, above, therefore, the line of junction of the diaphysis to the epiphysis.

The anti-brachial part consists of the following.

The *ulna* is of little interest as a whole.

We know the shaft possesses two curves like an elongated **S**. The upper convexity is on the radial side, the lower, on the contrary, is further removed from the radius and helps to increase the interosseous space. It ends in a flattened head like a lozenge, similar to the upper head of the radius. Around this head the radius turns excentrically and describes a circular movement.

At the inner part, the styloid process projects, bound by two grooves, one posterior for the extensor carpi ulnaris, and the other anterior for the passage of the flexor carpi ulnaris.

The triangular ligament arises from the styloid process passing as a meniscus between the head of the ulna and the cuneiform bone. The anterior and posterior radio-ulnar ligaments are inserted on its borders, and embrace crosswise the head of the ulna, to become inserted on to the anterior and posterior lips of the small sigmoid cavity of the radius. The internal lateral ligament of the radiocarpal articulation, vertical and tubular in form, embraces the whole of the styloid process of the ulna, on the base of which it is fixed, leaving its apex free, and is connected with the cuneiform and partly with the pisiform bones. The antero-internal ligament forms an apron extending from the radial border to the anterior edge of the triangular ligament, and to the ulnar fossa, and is fixed by its inferior head to the semilunar and cuneiform bones : it thus forms the internal part of the ligamentum arcuatum. The ulnar head is, so to speak, free at its posterior part. To sum up, two important ligaments are inserted into the ulna : (1) the triangular ligament, an intra-articular meniscus, separating the head of the ulna from the cuneiform and forming a sort of spring mattress, which deadens shock, but draws at the same time on the styloid process : (2) the internal lateral ligament which ensheathes the styloid process like a tube.

The *radius* is much more important. It must be noted, to begin with, its actual length between the head and the inferior glenoid cavity is longer than the actual length of the ulna included between the base of the sigmoid cavity and its head by about 4 millimetres. This length is still further increased by the styloid process. This fact is very marked on the plates. The thickness of the triangular ligament which is inserted below the sigmoid cavity, requires 2 or 3 millimetres in height to fill the free space between the head of the ulna and the carpus.

The head of the radius, whatever has been written on this point, is always in contact with the condyle of the humerus in every position. Barjon, Briau and I in 1897 have shown this to be the case and as a result the transmission of force is direct.

The radius, in contact also with the carpus, immediately receives the shock, whereas the ulna escapes the injury, the distance which separates it from the cuneiform being considerable.

The radius has two curves, one with its convexity external, the more important, since it allows the radius to move round the ulna and helps to change the axial movement at the head into a circular one, the ulna playing the part of a cog : the other, with an antero-posterior convexity much more marked at its lower extremity than in its middle part, produces a slight prominence 6 millimetres in height from the anterior lip of the glenoid cavity. This hollow part is filled by the pronator quadratus. The diaphysis is triangular, with an anterior, posterior and external surface.

The anterior and posterior surfaces unite at an acute angle to form the internal border on which is inserted the interosseous ligament. The external surface is round and is continued insensibly with the anterior and posterior surfaces.

At the lower extremity, the bone enlarges into a quadrangular pyramid. Internally, the anterior and posterior surfaces, united to the diaphysis, then separate to form the concave sigmoid cavity which receives the head of the ulna.

Externally, the external surface is more a rounded border than a true surface. It is hollowed out by grooves for the passage of the tendons of the abductor pollicis and extensor brevis pollicis : the posterior surface also possesses grooves for the extensor carpi radialis, the extensor ossis metacarpi pollicis, the extensor communis and the extensor proprii indicis.

The articular surface assumes the form of a triangular ellipse with its base internally and comprises : (1) a cavity internally, bounded externally by a slight ridge with the outline antero-posterior : this is the semilunar portion : (2) an external cavity more curved and triangular which is prolonged under the styloid process and descends with it : this is the scaphoidal part.

The epiphysis is formed of spongy tissue, and is feebler than the diaphysis. Voillemier noted a long time since the thinness of the anterior and posterior tables, which 15 millimetres from the radio-carpal space only exist as thin lamellæ, hence the fragility of the epiphysis. Again, whilst the posterior surface is nearly rectilinear, the anterior possesses a very marked curve, the summit of which is situated 3 centimetres above the interspace. This apex is a feeble point of resistance. Nélaton's theory of fractures from exaggeration of the curves of the bone, arose from these findings.

The posterior lip of the articular cavity, descending lower than the anterior, is turned towards this cavity below, in front and internally. This is why when the hand falls naturally as in vivo, its axis makes with the axis of the forearm an angle open internally.

The inclination of the hand to the ulnar side depends upon the obliquity of the line between the two styloid processes. In addition, it is to be noted (1) the first row of the carpus, more covered by the dorsal part of the glenoid than by its palmar portion, follows the axis of the forearm : (2) the second row, on the contrary, is on extension situated over the first to correct the position created by the glenoid.

The first row is thus wedged between the glenoid of the radius and the second row, the position of which on ex-

tension tends to push it back and to cause it to disappear behind under the posterior border.   It is very perceptible in the living.   If the gap corresponding to the os magnum be examined on the dorsal surface, with the hand extended, the dorsal surface of the semilunar can only be perceived for a small distance, and the superior border of the glenoid of the radius is found to overhang and ensheathe it.   These small anatomical facts explain why the semilunar has the free space on the palmar side and is closed on the dorsal, and also the difficulties of approaching the bone surgically by the dorsal surface.

To sum up, the radius being longer descends lower than the ulna : the difference in length is further increased by the form of its epiphysis.   It is in immediate contact with the scaphoid and with the semilunar, whilst the ulna is very far from the cuneiform.   Its apophysis descends on to the scaphoid and is only separated from the base of the first metacarpal bone by a finger's-breadth, whereas the ulna is separated from the fifth metacarpal by two fingers' breadth.

The radius, therefore, is more exposed to shock.   The spongy formation at its inferior extremity, and its antero-posterior curve diminish its resistance and explain the localisation of injuries.

The radial epiphysis appears about the age of two years, it is ossified about the twenty-fifth year leaving in the trabeculæ a tranverse black line which must not be mistaken for a line of fracture.

The epiphysis has the outline of a trapeze.   In Madelung's disease, it is triangular with the point internally, and this congenital deformity can be explained by an arrest of growth of the antero-internal part of the articular cartilage.

The radius is bound to the wrist by a series of ligaments : (1) the anterior ligament which forms a thick covering.   We can distinguish an antero-internal part arising from the ulna, and from the triangular ligament, and an antero-external part from the radius : it has the form of a **V** (ligamentum arcuatum of the Germans) or better of two **V**'s one within the other, the point of the first **V** being

inserted into the semilunar, and the point of the second
into the head of the os magnum. These two arched
ligaments are independent, the second being part of the
ligamentum radiatum of the Germans: these fibres
radiate round the head of the os magnum. The parallel
fibres do not interlace, so that the fascia between the radius
and the semilunar is often separated from the os magnum
by a small hernia of synovial membrane, described by
Poirier.

(2) The external lateral ligament, vertical, short and
conoid in form, descends from the styloid process of the
radius and is inserted into the external surface of the scap-
hoid.

(3) The posterior, a very thin ligament, which plays
no important part. The bi-styloid line marks the boundary
between the forearm and the carpus. It runs obliquely,
the styloid of the radius descending 7 millimetres below
the middle of the glenoid; the distance separating the sty-
loid process from the base of the first metacarpal bone is one
finger's-breadth, this is the measurement of the height of
the carpus at its external part. The distance separating
the styloid process of the ulna from the base of the fifth
metacarpal is double.

These two unequal heights form the external and internal
boundary of the carpal region.

The *carpus*, between the forearm and the hand, is re-
tracted below the styloid processes and forms the arch of
the wrist.

Protuberant and convex in the vertical and tranverse
direction on the dorsum, the wrist is excavated on the
palmar surface by a groove, which gives a passage to the
flexor tendons, to the ulnar and to median nerves and to
the ulnar artery.

This groove is bounded by two pillars which form a con-
siderable projection: one, externally, formed by the
palmar apophyses of the scaphoid and of the trapezium:
the other, internally, by the pisiform and the unciform
process of the unciform bone.

The muscles of the thenar and hypothenar eminences
are attached to these pillars: they are large masses ex-

ternal and internal, the first much the larger and descending lower than the second, its size and importance being governed by the functions of the thumb, so that the forearm and the hand cannot be supported in one plane at the same time. When the forearm is flattened, the metacarpals are raised and inversely, when the hand is flattened, the lower extremity of the forearm does not rest on the same plane. This bell-like movement has as its point of backward movement the two pillars of the carpus, especially the palmar apophysis of the scaphoid, the pisiform being of little account.

It can be said, then, there is a true tranverse arch of which the semilunar forms the summit and under which pass the tendons and the organs contained in the groove.

Consequently, the method of resistance of the carpus is quite a special one, and we shall see what position the first row can take on the second in the different degrees of extension only, because in flexion the pillars play no part, as the force is exercised on the back of the hand. The carpus consists of two rows of four bones, the one antibrachial, and the other metacarpal. The latter forms a mass with the metacarpus, and apart from the special movements of the solid trapeze of the thumb, it can be considered as forming a firm whole.

The first row is formed of three bones, for, in fact, the pisiform does not count, and it constitutes both the carpal condyle moving in the radio-carpal joint and the mobile glenoid, in which the second row moves through the radio-carpal joint. This is the chief point.

The first forms a movable and supple meniscus; movable, it changes its position in the mid-carpal joint : supple, the articulation of the bones forming it, allowing of its adaptation to the position of the hand.

I have already said the bones are not in the same plane, but form an arch in the tranverse direction, the palmar pillars of which are composed of the palmar apophysis of the scaphoid externally and the pisiform internally, giving rise to the outline of the thenar and hypothenar eminences. The semilunar occupies the summit of the arch : it is flanked by the cuneiform and the body of the

scaphoid. These bones form a curve and a groove through
which pass the flexor tendons and the ulnar and the
median nerves.

In addition to this tranverse curve, the first row forms
also an arch in the vertical direction, so that in a wrist
seen in front, the condyle represents an overhanging arch,
the key of which is occupied by the semilunar which is
also a key of the tranverse arch. The external pillar, the
scaphoid, descends much lower than the cuneiform pillar :
hence the irregular form of the mid-carpal line.

The rounded head of the os magnum is continued
internally by the inclined plane of the unciform bone,
whereas externally it is free, hollowed out by a neck,
which separates it from the rest of the bone, and in this
neck the lower extremity of the scaphoid is lodged.

The groove of demarcation is sometimes so deep that
there remains an empty space like a foramen between the
base of the scaphoid and the neck of the os magnum.

Certain morphological details are important to remember
in connection with the bones of the carpus. The *scaphoid*
especially, the bone most exposed to injuries, by reason
of its position, its length and its physiological rôle, has a
shape answering to its function. Its rôle is such that it
far surpasses in importance all the other bones of the carpus.
Diagrammatically it can be represented as a wire, the shaft
of which is curved into a vertical first part representing
the body of the bone, and its lower end bent perpendicu-
larly, the palmar apophysis. It can also be compared to a
block of wood, the large side of which curved internally to
embrace the head of the os magnum, would represent the
body, whilst the small side would represent the palmar
apophysis. As a matter of fact, and this will be seen by the
X-rays, in profile it appears like a bean, not vertical, but
inclined from above below, and from behind forwards,
whereas in front the curve of the body is seen, and its
apophysis disappears.

It has then two curves, one vertical to embrace in its
concavity the head of the os magnum, the other antero-
posterior, produced by the junction of its palmar apophysis
at an obtuse angle to the body of the bone. In this way,

there are two axes corresponding one to the body of the bone, and the other to the apophysis. This latter, as is known, answers to the displacement of the trapezium, in apposition of the thumb, a movement peculiar to man, and inversely, the scaphoid can pass into the said articulation with the trapezium, when the second row is fixed. We can distinguish in this small bone a vertical body with an upper extremity and a base prolonged in front by the palmar apophysis. Three articular surfaces encrusted by cartilage cover it nearly entirely; except a part of the postero-external surface, the whole is articular.

It can be described as follows :

(1) An external surface, which on its upper part is provided with cartilage, extending from the dorsal side as a large surface for articulation with the styloid process of the radius, and which posteriorly is covered by the posterior lip of the latter. Below this first part, a crest and tubercle are found, on which the external lateral ligament is inserted.

(2) A concave internal surface, which receives the external surface of the head of the os magnum, and above, there is a small semicircular part articulating with the semilunar.

(3) A triangular base articulating with the trapezium and with the trapezoid. The *semilunar* is crescentic in shape, or like the quarter of an orange. Its upper surface is convex : its lower, concave from behind forwards, articulates with the os magnum and with the unciform : its external semicircular surface articulates with the upper extremity of the scaphoid, its internal quadrilateral surface with the cuneiform, and its anterior surface, forming a beak, receives the apex of the **V** of the ligamentum arcuatum : its posterior surface, small and rough, smaller than the anterior, gives insertion to the dorsal ligaments.

The scaphoid and the semilunar are united by ligaments, to which some desire to assign an important part : they are subtleties of the scalpel and fall to the ground before the simple observation of facts. All observers had noted

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after dissection of the dorsal surface of the wrist, extensive
tilting movements of the upper extremity of the scaphoid
can be produced, by pressing on its apophysis. The
scapho-lunary ligament is very lax, and slightly thick,
and according to Bryce, is sometimes absent, and it can
be understood it does not form a serious obstacle, seeing
that the anterior ligament of the carpus can give way
from pressure or from a blow.

The ligaments and the connections between the scaphoid
and the semilunar have only one merit, viz. to serve as a
foundation for a theory more ingenious than true.

The anterior ligament, the arcuatum, has strong attach-
ments only to the semilunar, the other ligamentous con-
nections are feeble.

On the dorsal surface, the only ligament of importance
arises from the posterior border of the radius and is directed
obliquely from below inwards to the cuneiform. It binds
the semilunar posteriorly, but has hardly any insertion
into it.

On cutting and removing it, a small slightly resistant
bundle is found arising from the radius and ending in the
semilunar.

The transverse scapho-cuneiform ligament unites the
two extreme pillars of the glenoid cavity of the os magnum :
it passes below the semilunar, and there is, on this side, in
short, only the articular capsule, which is lax. It is
sufficient to extend and flex the wrist in order to feel the
complete mobility of the head of the os magnum, and the
laxity of the semilunar joint.

To sum up, the semilunar is very movable, both in the
radio-carpal joint and also as a part of the glenoid cavity
of the os magnum. On the one hand, on extending the
hand and seizing it between the thumb and the index
finger, in the antero-posterior direction, it is easily moved
in the living person, and it is very simple to displace it per-
ceptibly from before backwards : on the other hand, it
fits badly into the head of the os magnum, when moving it
forward from the inner side, and it still rests on the unciform.
The two beaks or horns, anterior and posterior, are not
very long, the longer, the anterior, is very narrow and as

its connections, excluding the ligamentum arcuatum, are very feeble, it can be understood its displacements are easy. The slight solidity, also, of its attachments is shown clinically by frequent failure of its nutrition : nearly entirely cartilaginous and suspended by some ligaments which convey to it its nutrient vessels, it, as a result of only a sprain, undergoes degeneration, which we shall have to consider and which shows in the same way the weakness of its attachments. But the chief point in its history results from the fact that in association with the scaphoid, it transmits directly the injuries of the radius to the second row whatever part of its upper surface normally rests both in the glenoid of the radius and also on the triangular ligament.

The *cuneiform* presents no great interest, because it is separated from the ulna by a large space, in which is lodged the triangular ligament. The scaphoid and the semilunar, therefore, constitute the essential part of the first row.

The *second row* is concentrated on the os magnum, the head of which, a true odontoid process, is the centre of the movements of the wrist.

The other bones are satellites of little interest, except the trapezium, but this latter belongs moreover to the hand by reason of the part it plays physiologically.

From the clinical point of view the os magnum is the centre of exploration.

When Desprès, in 1875, presented to the Surgical Society a case of mid-carpal luxation, Tillaux, Perrin, Poulet and Le Fort discussed the signs of this dislocation, and considered anatomy furnished them with landmarks. Here are their conclusions : it is necessary to examine for : (1) the point of the styloid process of the radius (if not broken) : (2) the space between the trapezium and the metacarpus, which is easy to discover by moving the thumb. The mid-carpal space corresponds nearly to a line uniting the styloid processes of the radius and of the ulna, and passes 15 millimetres above the articulation of the trapezium to the metacarpus. There should be marked in ink on the injured limb : (1) the abnormal transverse

prominence or depression : (2) the point of the styloid process of the radius : (3) the space between the trapezium and the metacarpus. If the case be one of radio-carpal luxation, the transverse prominence will pass many millimetres above the styloid process of the radius : if it be one of Pouteau's fracture, it will have its site 15 or 25 millimetres higher : if we be dealing with a carpo-meta-carpal dislocation, the line separating the prominence will start from the space between the trapezium and the metacarpus : if the luxation be mid-carpal, the line traced on the prominence will start from the styloid process of the radius and cross the hand in the transverse direction about 15 millimetres above the articulation of the trape-zium to the metacarpal bone.

If I have recalled these landmarks it is to show their puerility. The styloid process of the radius may be broken : the height of the wrist is not measured in the way de-scribed, but as I have said by the distance separating the styloid process of the radius from the space between the trapezium and the metacarpus and by the distance of the styloid process of the ulna from the base of the fifth metacarpal bone and, in addition, by the position of the os magnum, for which examination should be made. For this purpose, the middle of the hand is seized and with the back of the nail of the thumb search is made for the carpo-metacarpal space, which is easily recognised by the prominence at the base of the metacarpal bone : then, 2 centimetres higher the finger sinks into a cavity which becomes deeper as the hand is further extended, whereas, on the other hand, it is filled up by a prominence which raises the finger on flexing the wrist : this is the head of the os magnum. The head being recognised and marked out, follow the radius in the opposite direction, searching for the posterior lip : the distance separating the posterior lip of the radius from the head of the os magnum is 7 millimetres : this corresponds to the height of the first row, and especially of the semilunar.

These methods have lost none of their importance since radiography, but it is still necessary to know how to read the plates.

II. RADIOGRAPHICAL ANATOMY.—To begin with, here is a technical recommendation :

It is always necessary to have two plates, the one front view, and the other in profile. For the first plate, the posterior surface of the forearm ought to be laid on the plate, the thumb separated ,and the hand flexed. The incident ray ought to be directed on to the middle of the radio-carpal space. For the profile, the radius must be placed against the plate, and the hand must be in the same plane as the forearm.

This position is rather difficult to obtain : it is brought about by turning the arm and making the injured person bend the body, i.e. the arm ought to be a little higher than the body.

These precautions do away with many difficulties in interpretation by bringing together as far as possible the commonest faults in the plate.

Much discussion on the prints would be avoided by these simple measures. It is easy to find examples : the carpus seen from three points, gives the illusion of a dorsal luxation of the semilunar : many of the dorsal prominences of the os magnum appear on the radiograms much more exaggerated than in the living ; if, then, we wish to discuss certain details, it is necessary to remove errors of radiography, and to endeavour to avoid the deformities of the projections by the simple means which good sense dictates.

Reading and interpretation of carpal lesions have always been looked on as difficult. If the normal anatomy, the form, site and connections of the bones, be thoroughly known, the difficulties disappear. But we must recognise that, before radiography, the usefulness of this knowledge was not apparent, and, since then, anatomical study has been limited to a recital of the bones in their order, without troubling any more about the smaller bones, which did not seem to be destined to play a great part, and without differentiating their respective importance. During the whole period of experimental anatomy and pathology, the carpus was disregarded and the pieces collected from fractures of the radius did not include the bones of the wrist.

It seems to me to be useful to give a diagrammatic method of drawing the bones of the carpus and of dissecting, so to speak, a radiogram of the front view and of the profile of the region.

Commence by tracing a vertical line representing the axis of the forearm and of the hand. On the right of it, draw a small keel or a champagne cork : this is the shape of the os magnum with its head and neck : on the base a small external opening marks the position of the third metacarpal bone, on which is inserted the extensor carpi radialis brevior. Internal to this keel, draw an equilateral triangle, on which a large C or a large D is placed : this is the unciform with the projection of the unciform process.

On the other side of the os magnum, half-way up, place a small heraldic shield, with the point below: this is the trapezoid.

Lastly, encroaching on its shadow, a larger and pentagonal surface : this is the trapezium. This is the second row to which it is easy to add the metacarpals : two for the unciform, one for the os magnum, one like an **M** for the trapezoid, and lastly, the first metacarpal with a base like a saddle answering to the trapezium. The whole carpo-metacarpal mass is drawn.

On the vertical line, above the os magnum and a little internally, trace the shape of a trapeze, 12 millimetres in height : this is the semilunar.

On the same vertical line trace a right-angle triangle, like the large side of a block, 3 centimetres in height with a small base of one centimetre : this is the internal border of the radius with its sigmoid cavity.

Prolong the small base, for 3 centimetres internally, and mark the spot where the level of the head of the ulna should appear; this with its flattened head and its styloid process is not difficult to draw. Prolong the small base externally, i.e. always perpendicularly to the general axis, and on this line, at the height of the base of the trapezium, let fall a perpendicular 10 millimetres in length ; its lower extremity will mark the summit of the styloid process of the radius, and it will be sufficient to connect it by an arched

curve to the base of the small triangle to obtain the radial articular line.

It is quite easy to place the special form of the scaphoid externally. Internally, the cuneiform is a right angle laid on the unciform, and through which is visible the shadow of the pisiform.

Notwithstanding its appearance of a puzzle, this scheme is very instructive : it only requires a few details to make it complete.

In the first place, we must note the internal triangle of the radius divides into two lines for the small sigmoid cavity.

The posterior lip is badly seen and forms a shadow covering the upper part of the semilunar and of the scaphoid.

The dark line cutting through the styloid process is not a fracture, but the line of ossification close to the epiphysis. Fractures of the radius of Pouteau's type betray themselves by change in the trabeculation, which is irregular, and by the presence on the borders of slight splintering and of seams. The side view is, as we shall see, more instructive.

From the carpal side the scaphoid shows different normal appearances that must be recognised. It appears elongated in the form of a lozenge, its base spread out and a black line is visible dividing it : this is the projection of the palmar apophysis.

There is often seen on its external border a small roughness : this is the tubercle on which is inserted the external lateral ligament, which must not be mistaken for a line of fracture.

The prominent angle, which enters into the neck of the os magnum, is often separated by a foramen. If at the same time, as this opening appears to be 3 millimetres in breadth, the upper extremity of the bone be seen to approximate the semilunar, and this is recognised by diminution of the clear space separating the two bones, with a shadow on the head of the os magnum, it is because the scaphoid is displaced.

Sometimes, the scaphoid appears globular and diminished in height, sometimes, lastly, the angle, the palmar

apophysis forms with the body is apparent.   These
different appearances are easily made plain by the draw-
ings and by the reading of the plates in profile.   When the
scaphoid tips down, it appears diminished in height and
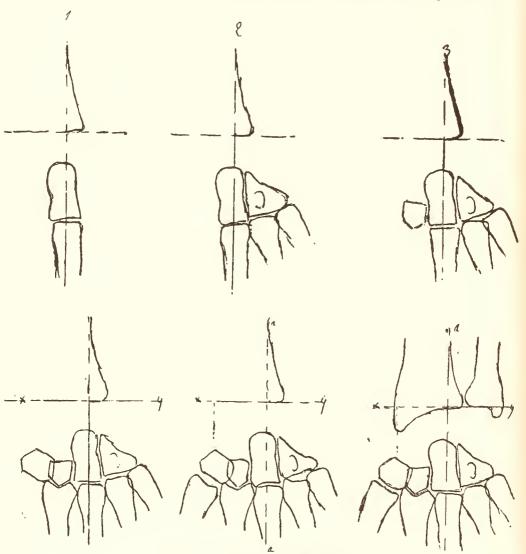
FIG. 1.—BONES OF THE CARPUS.

globular, and its upper extremity covers the dorsal surface
of the head of the os magnum and projects its shadow on
to it.   The clear band separating the semilunar from the
scaphoid is not more than 2 millimetres in breadth :
it is much larger in dislocations or in simple sprains.
   On profile, the scaphoid looks like a bean : its base is

always easy to trace, when the plate has been taken as I have indicated : its upper extremity is much less legible, its shadow can, however, be distinguished from that of the semilunar. The bigeminal appearance of the carpal condyle indicates the separation between the two bones. The semilunar is always very easy to find in profile, where its characteristic form is marked. In front view, on the
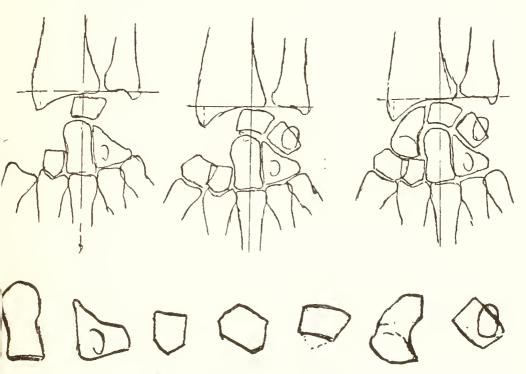
Fig. 1a.—Bones of the Carpus.

contrary, its appearance is very variable. Its form is quadrangular with two curvilinear sides : sometimes the hook of its anterior extremity is seen across the head of the os magnum and this fact shows it has dipped down in front : when at the same time the shadow of the upper extremity of the scaphoid projects on the head of the os magnum, an appearance like a draught-board is obtained, characteristic of subluxation of the scaphoid and of the semilunar.

The reading of the carpus in profile is now easily summed up.

Omitting the ulna, the radial articular line is perceived looking below anteriorly.

The styloid process is not ordinarily seen, sometimes it appears in the form of a triangle with apex below.

The semilunar shows a border like the slice of an orange, and the os magnum is in the position of dorsal extension.

The scaphoid passes crosswise on the os magnum, and doubles the shadow of the semilunar, above, without going beyond it : below, its apophysis projects in front and the trapezium is found below it.

It is always necessary to note in the readings :

(1) The distance between the cuneiform and the ulna, which ought to be 10 millimetres.
(2) The distances separating the scaphoid from the semilunar and the latter from the cuneiform.
(3) The appearance of the head of the os magnum.
(4) The breadth of the opening separating the dihedral angle of the scaphoid from the neck of the os magnum.

Such are the principal points in the reading of the radiogram of the carpus.

We shall see in each case, the differences by means of which a diagnosis can be made from a radiogram.

III.   Physiology.—The physiology of the wrist can only be well understood by considering the functions of the hand, that marvellous organ which adapts itself to all callings and to all arts, and which accomplishes without the least difficulty the most complicated movements. If the fingers be prehensors and act as sensitive, adaptable and strong pincers, if the forearm, by its movements of pronation and of supination allow of rotation on the axis of the limb, if the whole upper extremity give wide and extensive movements to the hand, the wrist adapts itself to every action, owing to its formation. It forms what is called in mechanics an universal joint, acting in two different planes, perpendicular to each other and allowing of the change without effort or without a pause of one position into another : extension, flexion, adduction, abduction and circumduction. These movements give to the portable forceps its suppleness and dexterity.

Nature has settled this question by an extraordinary contrivance, the equivalent of which is not to be found in the whole body, by means of a row of blocks interposed between the levers of the forearm and the carpo-metacarpal mass, the first row of the bones of the carpus.

This row is movable in the mid- and radio-carpal joints, it forms also a condyle in the radio-carpal and a glenoid
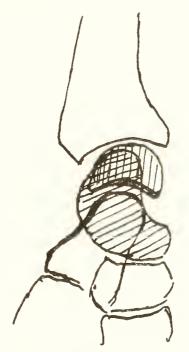
Fig. 2. Carpus. Side View.

cavity in the mid-carpal articulation : it thus doubles the extent of the movements of the wrist and assures by the mobility of the bones in antero-posterior and transverse directions the transition of one movement into another.

Looking at it more closely, it is seen, and radiography still more magnifies the point, two bones are of special importance, the semilunar and the scaphoid, owing to their direct contact with the radius : the hand is, in fact, waited upon by the radius.

The scapho-lunary system is vital.

This is not imagination : all the injuries of the wrist are almost contained in lesions of these two bones.

Again, of these two bones, one is only a block cut like

a crescent for the double purpose of acting in the radio- and mid-carpal joint : this is the semilunar ; the other, the scaphoid has a special shape which allows it to play a double rôle : by its body it forms a splint, the external pillar of the carpal arch, by its spread-out base projected forwards it forms a firm surface of support for the thumb, giving to it the firmness necessary for its opposition to the other fingers, and making it the chief branch of the manual forceps.

The attention of the practitioner is therefore concentrated on the study of these two bones. It is in vain for anato- mists and purists to wish to include the scaphoid and the semilunar in arbitrary classifications.

The first row of the carpus is an absolute fact.

The shape and function of the scaphoid and of the semi- lunar give them an individuality of their own. They cannot be denied, under the pretext of vague comparisons, a true entity, confirmed moreover by the whole pathology of injuries.

When it is desired to compare the function of the scap- hoid and of the semilunar to that of the astragalus, also another joint, it is forgotten the function of this bone is quite different, and the mobility which is the prerogative of the upper limb, has given place to stability and to distribution of the strength imposed on the foot.

The sub-astragaloid articulation is described as having a single function, whereas it is double. In the wrist, the scaphoid has its own individuality dependent on its function, connected with the thumb, and on its general rôle in the movements of the carpus.

This fact is so true, that we shall see in the study of the movements, this bone escapes in some general dislocations, by reason of its shape, of its length and of its function.

The researches I have carried out with my pupils, Briau, Gallois, Cousin, Tavernier, Gaulier, etc., since 1896, and which I have epitomised in my small book on the wrist, show if the scaphoid and the semilunar be given the importance and the rôle to which they are entitled both from ı athology and from observation, the difficulties met with in the study of the carpus and its articulations disappear.

The method I have followed is entirely my own : in place of pins fixed in the bones, and examinations, always untrustworthy on the cadaver, I have made use of radiography.

I have radiographed the hand, purposely in extreme positions, in adduction and in abduction, then flexed and extended. Tracings have been taken of the plates and the bones have been examined in the different positions adopted. By the superposition of the tracings, of the outlines of the radio-carpal and mid-carpal joints in the different and reversed positions of the hand, I have been able to write this new chapter of physiology. By bringing the bones into their axis, the figures have become more illuminating and the displacements more easy to read.

The mass of the carpus then ceases to appear as a block moving *en masse*. The first row becomes an entity, it executes its own movements distinct from those of the forearm and of the carpo-metacarpal mass.

The two columns or internal and external pillars become of physiological importance, which was to be expected from anatomy.

These facts are clear from an examination of the figures. Let us first follow the lateral movements of the carpus.

In abduction, the hand is inclined to the radial side and the carpus moves to the ulnar side by a true change of position.

To obtain an exact idea of this displacement, follow the semilunar, the os magnum and the third metacarpal bone, which, in the normal position, very well represent the axis of the hand. We see the semilunar has moved internally, approaching the ulna, it has then slipped over the glenoid cavity of the radius, but at the same time it has slightly pivoted on itself, since its lower articular surface has turned outwards. The os magnum has moved internally, its base to the radial side. The two bones are, therefore, displaced around an antero-posterior axis passing by the head of the os magnum, which has allowed the semilunar to turn to the ulnar and the os magnum to bring its base to the radial side. The displacement of the two bones has taken place in an opposite direction.

On looking more closely at the figures, it is seen the displacement of the semilunar is not so great as that of the os magnum.

The angle round which the semilunar has turned is less than that described by the os magnum.

This predominance of the angle of displacement of the os magnum shows the mid-carpal joint participates to a greater extent than the radio-carpal. It is evident, if the radio-carpal articulation played no part, and if the two rows formed only one mass turning round the same centre, the angles would be equal.

In adduction, inclination to the ulnar side, the same things occur as a whole, but in the opposite direction.

The semilunar moves externally, and is ensheathed under the radius, whilst it comes near to the styloid process.

At the same time it slightly pivots on its axis, and its inferior articular surface turns inwards.

The os magnum at the same time turns its axis to the ulnar side, i.e. in the opposite direction to the semilunar.

The two bones then turn round an antero-posterior axis passing through the head of the os magnum.

Here, again, the same description regarding the amplitude of the angles of the two bones and the different rôle of the mid- and radio-carpal joints applies.

In the movements of flexion and of extension, the dissociation between the first and second rows is clearly revealed.

In flexion, the semilunar glides from before backwards in the radio-carpal joint, and is lodged against the posterior border of the glenoid cavity of the radius. It rotates at the same time, turning its inferior articular surface forwards. It describes also a part of a circumference round a centre passing through the head of the os magnum.

This circumference is not exactly regular : the semilunar is slightly displaced laterally, depending on its shape, which is not quite spherical, and also on the obliquity of the articular radial surface.

The os magnum is displaced forwards in the opposite direction to the semilunar ; it describes also a circle round

a transverse axis, passing through its head. The displacement of the os magnum is greater than that of the semilunar, and this is still more a confirmation of the preponderating rôle of the mid-carpal over the radio-carpal joint.

In extension, the semilunar revolves over the glenoid cavity of the radius and supports itself against the anterior lip of the radius, at the same time as its articular surface turns backward.

The os magnum is displaced in an opposite direction, according to the movement of the hand.

Thus on considering only the bones representing the axis of the hand, we see they are displaced round antero-posterior or transverse axes, according to lateral movements, or flexion and extension, passing through a common centre at the head of the os magnum. There exists then a common centre for the movements of the wrist, and this centre is the head of the os magnum. This is why it pivots on itself and does not describe a parabola. The os magnum plays the part of the rudder of the hand, and the other bones grouped round it as satellites are displaced in connection with it. The true centre of movements of the wrist is in the mid-carpal joint, since the displacements occur round the head of the os magnum.

This fact brings to light also the double play of the first row which revolves in the radio-ulnar articulation, at the same time as it moves in the mid-carpal joint. Thanks to this double movement of the joint, the hand enjoys its marvellous mobility.

Everything would occur just as we have described, if the thumb did not destroy this beautiful harmony. The thumb has its own movements of opposition to the other fingers, and assists prehension. The thumb is, so to speak, added to the hand : the scaphoid is its chief bone. This bone has a special shape, on which we have laid stress. Instead of being a small bone indistinctly cubical in shape, it is elongated obliquely, resting on the os magnum partly embracing its head, descends on to its neck and expands in front in the form of a long palmar apophysis, which is none other than the external lip of the carpal groove and

the principal prominence of the thenar eminence. Its
lower surface rests in an articular surface in the trapezium.

Its length and shape prevent it moving freely as the
semilunar does. The figures are very clear, and allow us
to follow it in the different movements of the wrist.

On inclining the hand to the ulnar side, the scaphoid
follows quite well the movements of the semilunar and
glides under the styloid process of the radius. The radio-
grams show it elongated obliquely. No obstacle hinders
its displacement. This elongation, as shown by the
radiogram, is really the result of a movement of rotation
of its palmar apophysis, followed by the thumb which is
inclined internally.

On bending the hand to the radial side, the scaphoid
enters under the glenoid cavity and it may hit against the
ridge separating the radial surface into two cavities, or not
finding sufficient room to follow this course, as a result of
alterations in the curve of the articular surface of the
radius, it is stopped on its change of position. Being no
more able to move normally, owing to lateral pressure of
the os magnum, it executes its bell movement which brings
its upper extremity behind and its base in front. The
thumb turns slightly at the same time on itself in front.
The radiograms show the globular scaphoid as doubled on
itself.

It is this pivot action of the scaphoid on its longitudinal
axis which gives sufficient play for the inclination to the
radial side to be continued into the mid-carpal joint, when
it has ceased in the radio-carpal articulation. This ex-
plains why the circumference of the mid-carpal articula-
tion, in its external part, can fit into the contour of the
joint in a normal position.

The modifications of the scaphoid, in the movements
of flexion and of extension of the hand, are also very marked
and result from identical causes. In flexion, the scaphoid
moves horizontally under the radius, its upper extremity
follows the semilunar, i.e. it passes behind, and its base
follows the os magnum and moves forward. It turns round
its own axis, which shows it truly belongs, from its length
and shape, to both rows.

Fig. 4.—Abduction.

Fig. 3.—Abduction.

In extension, the upper extremity of the scaphoid accompanies the semilunar and becomes wedged against the anterior border of the radius ; by its base it follows the os magnum and, takes as a whole, a position nearly vertical, the whole importance of which is quite obvious.

TRAUMATIC PHYSIOLOGY.—This study of the physiological movements of the wrist would be only of slight interest
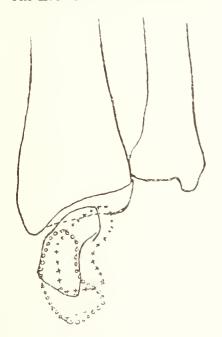
FIG. 5.—SCAPHOID ON ADDUCTION
AND ON ABDUCTION.
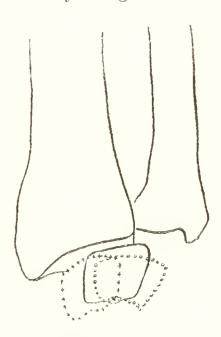
FIG. 6.—SEMILUNAR ON ADDUCTION
AND ON ABDUCTION.

if it did not lead us to practical points : the modifications brought about, in the point of application of the force, by the different attitudes in falling, ending in continuous extension or flexion.

It is a necessary preliminary to the knowledge of the mechanism of injuries of the wrist.

We must see why and how the inclinations of the hand can vary the point of application of the force and how the degrees of flexion and of extension act. Falls are usually on the palm of the hand : all interest is concentrated on this attitude of sustained extension, for it shows us particular changes and does not resemble non-sustained extension.

If we examine the position the bones of the first row

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take in sustained extension, we see the semilunar forms the summit of a transverse arch subtended by the flexor tendons ; it caps the head of the os magnum horizontally but overhangs it in front, so that it is slightly out of the perpendicular.

The scaphoid, pulled on by extension of the forearm, becomes straightened, and vertical in the form of a bridge thrown between the radius and the ground. Its apex is in contact with the posterior lip of the radius, its palmar apophysis rests on the ground. These two bones support the whole pressure of the radius, and as a result the weight of the body in falls on the hand : the cuneiform removed from the radius is not subjected to injury in normal extension.

If in this position a fall occur, the radius will lean its whole weight against the two radial bones, the semilunar and the scaphoid. The semilunar, wedged between the head of the os magnum and the radius, will endeavour to escape in front, the only way which is freely open to it, by breaking its ligamentous attachments.

The scaphoid caught between the radius and the ground, tilts under the action of the palmar apophysis. Its summit is carried backwards to its maximum, whilst its palmar apophysis becomes more and more in closer contact with the ground. This forms the bell movement, which the two bent axes imprint upon it, each time pressure is exercised on its palmar prolongation.

There is then, under the action of pressure, a different reaction between the semilunar and the scaphoid (contrary to what occurs in non-sustained extension); it is the beginning of a diastasis between the semilunar and the scaphoid, a physiological dislocation of the carpus. This physiological dislocation dominates the whole of the traumatic pathology of the wrist. According to the degree of extension of the forearm on the hand, the points of support are modified and the results from an injury vary. If the radius be at an angle of 45 degrees in relationship with the hand, its articular surface fitting into the semilunar will tend to force this bone into the head of the os magnum.

If, on the contrary, the forearm is at an angle of 90 degrees, the radial surface passing over the back of the semilunar will cause the latter to protrude under the anterior ligament of the carpus, and its connection with the head of the os magnum will become very unstable.

It can be understood a violent injury occurring in hyperextension can push the semilunar through the anterior ligament.

The scaphoid only exercises a single movement by reason of its two axes, its apophysis tipping it posteriorly. Owing
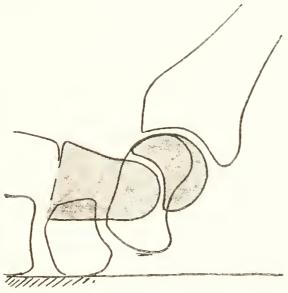
Fig. 7.—Maintained Extension.

to the violence of the injury it will endeavour to luxate posteriorly, and if this do not occur, it or the radius will break.

In every case always, the dominating factor is the dislocation of this pair of bones, the scaphoid and the semilunar, one bone trying to shift posteriorly and the other anteriorly.

By keeping the hand extended, if the lateral movements be changed whilst the forearm is inclined to the radial or to the ulnar side, the carpal condyle is more or less ensheathed by the radius, and hence the varieties in the pathological lesions.

In bending the hand to the ulnar side, the semilunar

occupies the top of the first row, and is called upon to support the whole blow. This is observed in falls on the hypothenar eminence.

The lesions of the semilunar depend on the degree of extension of the forearm ; at 45 degrees the semilunar firmly caps the head of the os magnum, and its resistance being greater than that of the radius, it is this latter which will give and break : rarely, but yet sometimes, the semilunar is crushed between the anti-brachial malleus and the carpo-metacarpal incus.
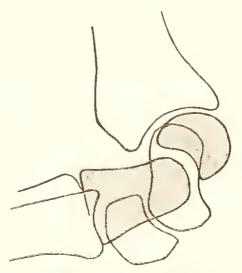
Fig. 8.—Maintained Hyperextension.

When the axis of the forearm is at an angle of 90 degrees to the hand, the semilunar, being out of the perpendicular on the head of the os magnum, will tend to escape in front or behind, but more often in front where luxation is very frequent.

The scaphoid only comes into play when the semilunar is broken or luxated. If the bend of the hand to the ulnar side be sufficient, it escapes posteriorly without breaking : if not, it is broken by exaggeration of the curve, and on tilting it can either break the styloid process of the radius, or enter as a spur into the radius.

On bending the hand to the radial side, the scaphoid is entirely under the glenoid cavity of the radius and gives support to the shock, whilst the semilunar has become

lodged under the spring mattress of the triangular liga-
ment. The position of the scaphoid is here of the first
importance : it is seen, in fact, on end tightly wedged
between the radius and the ground, its apex propped
against the posterior border of the radius.

This position corresponds to a fall on the thenar eminence,
i.e. the most frequent fall. When the injury is a violent
one, the scaphoid, powerfully ensheathed and making one
mass with the carpal condyle, most often resists, and the
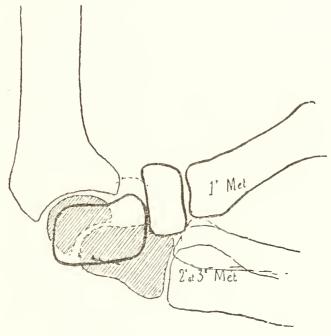
FIG. 9.—FLEXION.

radius breaks : rarely, the force is concentrated on it,
and then on endeavouring to tilt, it is broken against the
radius or by exaggeration of its curve.

The classical deformity of swelling on the back of the
hand, in cases of fracture of the radius, must be attributed
to the scaphoid, because, as we have just seen, it is this
bone which supports the greatest amount of pressure in
falls on the thenar eminence, which are the most frequent,
and which by resting posteriorly on the surface of the radius
escapes whilst driving back the fractured radius.

This is not imagination, the fact is patent, since experi-

mentally I have been able to produce fracture of the scaphoid by bending the hand to the radial side, which reproduced the position assumed in falling on the palm of the hand, with the arm away from the side, i.e. on the thenar eminence. The positions in falling react on the different types of fracture of the wrist, and experience and pathology fully show it.

Maintained flexion differs little from the non-maintained form : the semilunar becomes lodged against the posterior
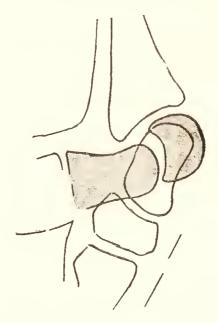
Fig. 10.—Free Hyperextension.

lip of the radius and continues to cap the upper surface of the os magnum, encroaching on its anterior curve. The scaphoid is horizontal. The pressure will then be exercised on the two radial bones, and most often fracture of the radius will be the result.

There is a variety of hyperextension which is clinically of real importance, this is free hyperextension; such is found in a fall not on the palm, but on the head of the metacarpal bone, or even on the fingers.

This hyperextension depends upon an exaggeration of the position of the bones in free extension. The semilunar thrown forward leans against the anterior ligament of the

carpus, passing beyond also the anterior border of the radius.

The scaphoid does not perceptibly tilt, but comes also in contact with the anterior ligament.

The posterior border of the radius impinges on the neck of the os magnum, and acts against it like a lever, so as to stretch to the maximum the anterior ligament. The damage which can result from the above is logically very various, but having observed only one radio-carpal luxation, we do not wish to draw any precise conclusion.

From this exposé, it is seen the wrist is an anatomical and physiological whole, and fractures of the radius and of the carpus arise from identical causes and in every case their study cannot be separated.

SPRAIN AND SUBLUXATION OF THE SCAPHOID AND OF THE SEMILUNAR

THE first, the simplest and the commonest lesion of the wrist, is sprain. We understand under this name a temporary dislocation with tearing of the ligaments, accompanied with swelling, œdema, ecchymosis and pain.

This apparently precise definition is not so in reality, and a sprain, from a clinical point of view, often includes lesions which radiography now permits us to recognise, but which formerly escaped us.

It is not rare to find, in the wrist especially, a scapholunary subluxation, a true diastasis existing between the two bones, and even small fragmentary fractures which show themselves afterwards as fine needles torn from the articular surfaces, and also sometimes some small fragments detached, for example, from the base of the scaphoid. These small osseous lacerations do not really deserve to be classed as fractures of the scaphoid, and their pathogenic history is quite different.

Again, there are hidden under the cloak of sprain, secondary troubles of nutrition and elevations and separations of the cartilage, and there is often noted secondarily a lacunary appearance of the semilunar or of the scaphoid with persistent pains. These sequelæ of a sprain were badly known. There are some bad sprains with persistent pain and loss of function, and these incidents were explained by rheumatism : to-day we better appraise the facts. Their history is contained in two words. The bones of the carpus are badly nourished by vessels, whose support is found in the ligaments, and when these are broken troubles of nutrition are easily produced and easy to understand, but formerly unknown.

Kienbock was the first to note these special disturbances, and naturally the number of cases increases every day. Baum ("Beitr, für klin. Ch.," Dec., 1913) has seen two cases subjected to operation. We see we are far from the old view of sprain, and this modern idea answers to exact and undoubted observations. Sprain can therefore remain

to-day as a clinical type, but on condition that we know it has to do not only with a temporary luxation with tearing of the ligaments, but also with all those factors we have just mentioned : scapho-lunary subluxation, small osseous lacerations, ossifications of the periosteum and the whole sequelæ of disturbances of nutrition resulting therefrom, which keep up loss of function and are a constant cause of pain.

In order not to multiply the chapters with classes and sub-classes, we have preferred to retain only the name of sprain, adding thereto the idea of diastasis or of scapho-lunary subluxation, for the different lesions we have noted show nothing special clinically. It is a mixture of lesions formed by affection of the subcutaneous cellular tissue and of the ligaments, hernia of the tendons and lacerations of the aponeurosis, all of which are invisible to the X-rays, to which are added permanent displacements of bones, new ossifications, comminuted fractures and signs of secondary ossification, perfectly marked on the plates. We thus have : (1) mild and simple sprains, where only clinical signs are marked : (2) more serious sprains with subluxation of the scaphoid and of the semilunar, visible on the plates : (3) sprains where the subluxation has been reduced, but where the ligaments have torn away some small fragments of bone and formed osteophytes : (4) old sprains with osseous degeneration : (5) a quite rare type, spring wrist, depending on recurrent subluxation of the scaphoid and of the semilunar. Consequently, from the purely clinical point of view, a single class, from the radiographical side a series of lesions which explain the gravity of the prognosis in certain cases.

The clinical history of the injuries is very simple. As a result of an injury, a fall on the palm of the hand flexed or hyperextended, or on the head of the metacarpals, from the recoil of the handle of a motor, or from a badly directed blow from the fist, the injured person feels a sharp pain in the wrist, with resultant swelling in the anatomical snuff-box, with œdematous infiltration, the development of which can sometimes be followed by marked loss of function caused by the pain, ecchymosis appearing in the

thenar eminence 24 to 48 hours afterwards, and slight diminution in the height of the wrist. These symptoms are not accompanied by a swelling on the back of the hand, by a typical deformity or by crepitation : there is felt only a swelling, sometimes very hard, which fills up the anatomical snuff-box, and may give rise to the belief in a fracture of the scaphoid.

A rare form is met with in subjects, perhaps predisposed to it, as a result of a clumsy movement. The injured person feels a crack and the shape of the hand remains fixed : any active movement of pronation as well as supination, extension and flexion is impossible : the wrist is locked. Slight traction on the hand, a blow of the thumb in the anatomical snuff-box and the functions of the wrist return.

The same condition can be produced in the same patient on the same quick movement ; this is spring wrist, facilitated by a particularly lax joint, and forms a special type. The occurrence is not rare in some gymnasts—I have seen it in a boxer—it is a recurrent subluxation of the scaphoid and of the semilunar.

The examination of the different symptoms we have just enumerated shows little importance in itself. Pain is immediate and sharp, almost producing syncope, or, on the contrary, it may be late in appearing, the patient feeling nothing at the time, but it occurs an hour or sometimes many hours after the accident, and increases for 24 to 48 hours and gradually diminishes. Its localisation on pressure is quite fixed, the painful point is situated below the styloid process of the radius, either posteriorly, anteriorly, externally or in the anatomical snuff-box, but the whole of the internal part of the wrist is free : movements increase the pain and, if, knowing the ordinary site of the lesions, the pulp of the finger be pushed into the space between the scaphoid and the semilunar, and the hand moved, the patient cries out. In the same way, if search be made for the space between the scaphoid and the trapezium whilst pressing and moving the thumb, acute pain is elicited, when all exploration internally is perfectly borne.

The swelling appears rapidly or slowly : the latter is more frequent, is localised to the external part and rises but slightly on to the forearm, descending, however, on to the hand, and usually stopping at the root of the fingers. It reaches its climax between 24 and 36 hours and ordinarily disappears in 6 or 8 days.

Persistent swelling may be deceptive : if it be slightly hard, it is attributed to a fracture of the scaphoid. In Gaulier's thesis I have reported the observation of a man studying for the army, who received a sprain whilst boxing. The swelling was such that Dr. Baudet of Toulouse thought the scaphoid was fractured. On examining the injury three weeks after the accident, and finding doughiness and prominence in the snuff-box and functional disturbance, I confirmed this diagnosis, which radiography refuted.

Decrease in the height of the wrist only appears when there is persistent scapho-lunary subluxation. In this case, a hard prominence is felt in the snuff-box. The wrist only diminishes in height on two conditions : (1) the scaphoid, by tilting, must have diminished in length : (2) the semilunar must be in its normal place on the head of the os magnum. I have mentioned how to measure the distance from the styloid process of the radius to the carpo-metacarpal space of the thumb.

The skin is shiny and hot. Ecchymoses are, however, rare ; they are found in front in the thenar eminence, especially when the patient has fallen on the palm.

Loss of function and limitation of movements appear immediately. The wrist is, as a result, locked : sometimes the injured person loses, so to speak, all active movement only after 24 hours. Passive movements are always very limited, particularly bending to the radial side. The movements of the thumb, more especially, are painful and diminished.

In subluxations, loss of function extends also to the movements of pronation and supination, and often yields suddenly to simple traction of the hand.

The progress of a sprain is usually simple : after 5 or 6 days of rest, and the application of a cotton-wool pad, the

injured limb by degrees recovers its function. This can
be aided by massage and vapour douches, but they should
not be abused, especially if the person be young.   It is
better to move the limb gently and especially to compel
the patient to move it unaided : pain is the best dyna-
mometer. This evolution is from time to time interrupted.
The pain and loss of function are persistent, sometimes
intermittently so : on a slight quick movement a sharp
lancinating pain reminds the patient of his old injury.

Successive exacerbations of pain can occur, and the
patient complains of loss of power : briefly, instead of dis-
appearing in from 8 to 15 days, the pains, loss of function
and swelling continue, and radiography shows a peculiar
appearance in the form of the semilunar, or of the scaphoid.

Lastly, some cracking and pains may persist in the joint
between the scaphoid and the trapezium, and the patient
loses a great part of the power of prehension, of squeezing,
and of the movements of opposition of the thumb : some-
times abduction of the thumb is limited. These slight signs
were attributed formerly to rheumatism.

All the symptoms we have just analysed can be met with
also in a fracture of the radius, but in these cases the idea
of fracture predominates, and we shall have to study
particularly the rôle of scapho-lunary sprain, either as a
determining cause of a special type of fracture of the radius,
or as a complication of this fracture.

The point we wish to note is this : the isolated sprain we
have described can be considered as the first stage of certain
fractures of the radius or as a first degree of dislocation of
the carpus.   Hence the importance of this study ; but first
let us examine the radiographical pathological anatomy.

RADIOGRAPHICAL STUDY.—Reading and interpretation
of the radiogram are of vital and essential importance.
Fractures of the scaphoid and certain partial fractures of
the radius can be perfectly simulated by sprain. Nothing
is more difficult than to determine exactly the small
additional lesions and the part the injury has played, and
which is so often invoked in all bacillary and infectious
conditions.   I have lately seen in Oudjda a sharp-shooter

who described a fall to explain the presence of a tubercular wrist which could not be recognised without radiography, the clinical signs were so like those of sprain.

Reading the plate allows us also to understand the occurrence of abortive and persistent lesions in their first stage.

I ought at first to mention the normal images are not always identical in themselves. The scaphoid especially presents numerous normal varieties depending on the person's profession, age and sex, and above all on his position at the time the plate is taken. I have already said the hand ought to be upright, the bones of the forearm supported on the plate, the thumb a little separated and quite flat. In these conditions, the scaphoid is sometimes navicular, like a bean, embracing the head of the os magnum; sometimes its lower end is flattened like a cachet, sometimes lastly, if the ligaments be lax, it may be globular and seem shortened, whereas it is only slightly tilted.

But what do we see in the subluxation due to sprain?

Firstly, the scaphoid appears globular and shortened, but this is not all. Its upper extremity overhangs the dorsal surface of the os magnum and thus makes a very marked shadow on the head of the latter. The distance of the dihedral angle which its base and apophysis form may be increased from the neck of the os magnum, but what must be noted above all is the space between the scaphoid and the semilunar, which is not normal; sometimes it is increased and exceeds 2 millimetres in breadth, sometimes it is diminished, and the scaphoid appears continuous without a marked line of demarcation from the semilunar on which it lies.

The semilunar appears to be continuous across the head of the os magnum by a point which makes a very marked shadow. It is its anterior extremity which is visible, as a result of tilting in front.

The head of the os magnum appears like a draught-board, as a result of displacement of the two bones.

The side view is indispensable : by it we can note the respective positions of the two bones : the upper extremity of the scaphoid is usually tilted behind, whilst the semilunar
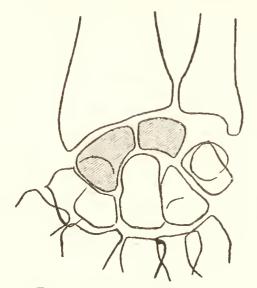
FIG. 11.—NORMAL WRIST.

The seaphoid and the semilunar are nearly in contact. The tail of the semilunar is non-existent.
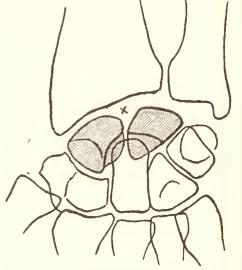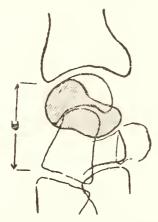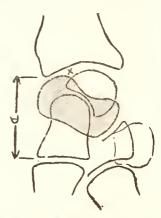
FIG. 12.—SUBLUXATION OF THE SCAPHOID AND OF THE SEMILUNAR.

The seaphoid and the semilunar are separated from each other. The tail of the semilunar appears like a Y.

The upper borders of the scaphoid and of the semilunar form one eondyle with the radius.

D = Height of the semilunar plus the height of the os magnum.

The two separated bones form two eondyles for the radius divided by the opening X.   D = shorter.

has glided in front over the head of the os magnum.   There is therefore a dislocation of the scaphoid and of the semilunar, and the carpal condyle appears bigeminate, for the curves which the bones make have no longer fitted into each other.   These last signs are of value only when the plate has been well taken in profile, and when the radial border of the hand rests on it.   Any variation either in the
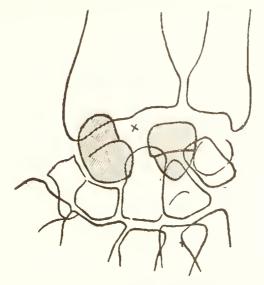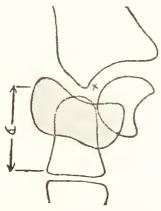
Fig. 13.—Dislocation of the Carpus
(luxation of the scaphoid and of the
semilunar).

The scaphoid and the semilunar are
widely separated from each other.
The tail of the semilunar is a well-
developed Y.

The opening has greatly increased.
D = Height of the os magnum, which is
markedly developed.

position of the tube, or in the profile of the hand, gives
rise to error. The figures show the appearance of the pro-
jections.

It is not rare to see some small osseous needles torn
away between the scaphoid and the semilunar and between
the latter and the cuneiform. At the base of the scaphoid

a slight fracture may also be seen, produced by tearing
from the violent tilting of the bone which has endeavoured
to escape at its articulation with the trapezium. In one
autopsy Tavernier found this articulation full of blood
(Gaulier's thesis, 1913), and the ligaments between the
scaphoid and the trapezium torn.

Lastly, in old cases, I have noted in my little book on
the wrist that curious mottled appearance, sometimes
seen, especially in the structure of the semilunar, and I
have attributed it to the trophic affections so often observed
as a result of arthritis. The Germans have not hesitated
to remove the bones affected in this way, and have found
a true cystic degeneration and separation of the cartilage
which is no longer bound to the subjacent spongy tissue
of the bone, and which is due either to the injury itself,
or rather, in my opinion, to fault in the nutrition from
tearing of the vessels in the ligaments. The importance of
these distinct findings cannot be overlooked : these are
the lesions which make the prognosis of a sprain serious,
although the injury has been slight. We must also add
the diminution in density, especially marked at the base
of the metacarpals, and the enlargement of the trabeculæ
and the fatty and rarefied appearance of the bones, are
the cause of a diagnosis of an arthritis with osteopathic
affections.
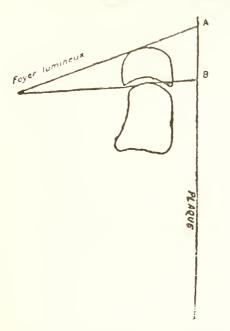
It is seen from all these anatomo-pathological details,
the diagnosis is not established by a single sign and
appearance, but from the examination of the whole.

It is easy by the plate to eliminate fractures of the
scaphoid, or of the radius, but difficult to settle the cause
of the arthritis and especially of the presence of tuber-
culosis.

But, in recent cases, the diagnosis is easy, because of the
localisation of the disturbances. In tuberculosis, the
tendinous sheathes are nearly always invaded and a much
more extensive rapid osseous degeneration occurs from the
first. The typical displacement of the scaphoid and of the
semilunar, sometimes seen, is always accompanied by
lesions of the os magnum. In tuberculosis, all the inter-
osseous spaces are enlarged, with no clear-cut outline,

Fig. 14.—Semilunar in Normal Position. Light.

AB represents the part of the semilunar above the os magnum. The shaded portion is the part of the semilunar projected in the os magnum.

Image obtained.

Semilunar subluxated. Light.
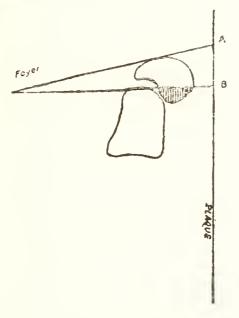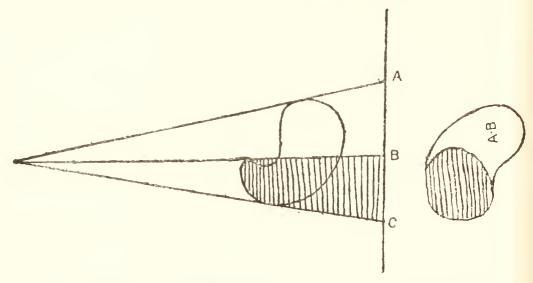
The semilunar is subluxated: its height A′B′ above the os magnum is less than AB, but the part below the head of the os magnum has increased.

Image obtained.

(These figures are taken from Gaulier's thesis.)

E
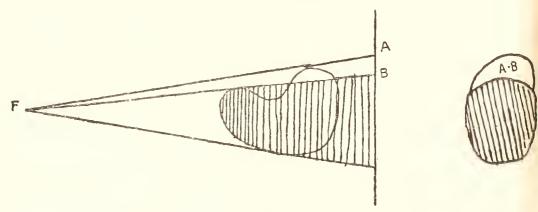
FIG. 15.—SCAPHOID IN NORMAL POSITION.

The seaphoid eonsists of two parts :
The body which projeets its shadow AB.
The apophysis (shaded part) between B and C.

Image obtained.

SCAPHOID POSTERIORLY.

The body of the seaphoid does not pass beyond the
shadow formed by the apophysis, exeept by the
distanee AB.

Image obtained
(globular seaphodi).

whereas in a sprain the lesion is more localised, and the
neighbouring bones are rarely affected.

To sum up, what do we see ?

(1) In the scaphoid, tilting of the bone. The scaphoid
has escaped pressure, from the injury, by a movement
natural to it. Its upper extremity is carried backwards
on to the back of the os magnum : its lower extremity

has tilted forwards in its articulation with the trapezium : above, it has torn the ligaments between it and the semi-lunar ; below, those between it and the trapezium. Autopsy and the presence of comminuted fractures of the base have shown me this. The altered relationship with the semilunar and the small ossifications on the scaphoid and on the semilunar are evidence of the tilting movement. Projection on the plate shows at the same time apparent diminution in the length of the bone. This luxation of the scaphoid and of the semilunar or, to be more precise, of the semilunar, of the os magnum and of the trapezium from the
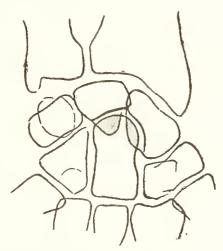
Fig. 16.—Appearance of the Head of the Os Magnum like a Draught-Board.

scaphoid cannot be disputed : persistent or temporary, the occurrence is undeniable. This tilting of the scaphoid depends on its length, its two axes and their angle. I have insisted on this movement and need not return to it.

(2) The signs are less marked in the semilunar : the bone in permanent luxations glides in front over the head of the os magnum, and dislocation of the condyle results, but the connections with the glenoid cavity of the radius and with the head of the os magnum are not very much altered. It is always in contact whatever be the abnormal displacement in the two joints. In a simple sprain everything returns, or nearly so, to its place, and nothing is to be seen if the scaphoid have regained its normal

position, and if the torn ligaments have not caused periosteal ossifications or degenerative trophic changes. This double movement explains itself, when we are dealing with a fall, either on the palm of the hand in extension, or on the dorsal surface in flexion. It is not the same in non-maintained extension, because in this case if, strictly speaking, we allow violent traction on the hand tears the scapho-trapezial ligaments, on the other hand the upper extremity of the scaphoid must tip forward. I do not also pretend to make the pathogeny I have advanced suit every case, and I allow this opposite form of sprain. Many sprains discovered on clinical examination have no radiographical signs, but in the majority of cases the lesions I have just described are met with, and as they represent the first stage of dislocation of the carpus, and as they are found to be the cause of certain types of fracture of the radius, they take from this fact an importance, which I consider should be emphasised, and which the continuation of this study will clearly develop.

The *treatment* of sprain or subluxation of the scaphoid and of the semilunar is very simple, and I have already indicated it. I prefer to massage and friction, immobilisation for five or six days with a small cardboard splint, leaving the fingers free. A cotton-wool pad rapidly brings about resolution of the exudate. The hand ought to be inclined to the ulnar side, and slightly flexed. A blow of the thumb in the anatomical snuff-box with extension of the hand most often permits reduction of the subluxation. In the case of locking of the hand, the same manœuvre often serves to put everything back into its place. After reduction of recurrent subluxation, it is a good thing to wear a bracelet of supple leather, laced and tightened, like that of wrestlers and of butcher boys. Lastly, if a lacunary or cystic condition of the semilunar be found, producing persistent pains, resection of the bone should be tried : it has given good results in certain cases, but I ought to state I have had no personal experience of it.

FRACTURE OF THE SCAPHOID

AMONGST the most characteristic injuries of the carpus, fractures of the scaphoid occupy the first place in frequency and in variety. The history of these fractures dates from the time of radiography, and it is astonishing, considering their number, they should have escaped the old observers. The few facts noted were rather the findings of autopsy, or curiosities.[1]

The first case I observed dates from November, 1896 : it led me to make a clinical and experimental study (thesis of Cousin, 1897, and of Gallois, 1898), from which I could determine, on the one hand, how fracture of the scaphoid could be experimentally produced, and on the other, the rôle of this bone in fractures of the lower end of the radius (scaphoidal theory of the swelling on the dorsum of the hand).

Since that time, the number of my observations has greatly increased, and scarcely a week passes without my having the opportunity of seeing this lesion.

I have described at length the anatomical and physiological reasons which explain the multiple injuries caused by the scaphoid, and which make this bone a traumatic centre, and I will not return to them : but before entering on a special study of the different types of fracture of the scaphoid, it seems to me to be of interest to look as a whole at the numerous radio-carpal lesions where this bone is found to be concerned : by that means we shall understand the interest attaching to it.

GENERAL REVIEW. — If we enumerate the different lesions in which fracture of the scaphoid is encountered, we are struck by their diversity.

Besides isolated fractures with their different anatomo-pathological forms : fracture of the upper extremity, of the middle part, of the base, and comminuted fracture, and their various methods of production, a fractured scaphoid is met with in a series of combinations. There are fractures associated with (1) that of the radius : (2) that of the

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[1] Cloquet, Jarjavay, Guibout, Flower, Rutherford, etc.

trapezium : (3) that of the trapezium and of the radius :
(4) that of the semilunar : (5) dislocation of the carpus :
(6) mid-carpal luxation.   These groups are not always
single : there may be found simultaneously fracture of
the radius, of the scaphoid, and of the semilunar, or
of the trapezium, of the radius, of the scaphoid and of
the semilunar, and we can judge from this enumeration
only what anatomo-pathological complications can be
revealed by radiography.

To begin with, it is important to sort out of this mass of
facts some clinical types. To group the lesions, we must
look into the pathological physiology and observe the
dominating character under which they can be classified.
In isolated fractures the question does not arise.

The variety of the lesions shows it is impossible to find
in their method of production and in their pathogeny a
means of classification, which, here as elsewhere, only
rests on the imagination of the authors. We shall have
merely to describe the different forms.

We can divide combined fractures into three :

(1) Fractures associated with the semilunar : fracture,
    luxation, mid-carpal luxation :
(2) Fractures associated with fracture of the trapezium :
(3) Fractures associated with fracture of the radius.

In the first, the fracture of the scaphoid is accessory.
Luxated or broken, the semilunar shows the prodominant
lesions, and their study requires a special chapter.

In the second, association with fractures of the trapezium
is rare and without great importance : we shall not
dwell on them.

The third remains, and it is very important. The number
and forms of fractures of the lower end of the radius
have considerably increased since radiography has allowed
us to discover partial fractures which have neither
symptoms nor classical deformities.

We shall have to study these fractures in detail : we
wish only here to treat of a difficult point in their history,
namely, the connections of fractures of the radius with
those of the scaphoid.

Lesions of the scaphoid can be found in three classes of quite different fractures of the radius :

(1) In extra-articular fractures : Pouteau's type, oblique, etc. Fracture of the scaphoid is here accessory :

(2) In intra-articular fractures : splintering of the epiphysis. Fracture of the scaphoid plays here an important pathogenic rôle, but the dominating symptoms are those of fracture of the radius. The scaphoid holds
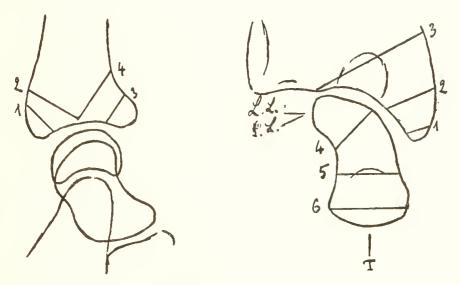
Fig. 17.—Drawing of the Different Types of Isolated and Combined Fractures of the Scaphoid.

the second place, its lesion simply complicating that of the radius :

(3) In partial intra-articular fractures of the radius. Here the rôles are inverted, the fracture of the scaphoid predominates : that of the radius, having no marked symptoms, passes unnoticed. Clinically, fracture of the radius is in its turn nothing but a complication. These three classes could be described as degrees and varieties of fractures of the radius, but I believe it is a good thing to bring together the last class of carpal lesions, which they accompany and complicate, because these types of partial fractures are met with not only with fractures of the scaphoid, but also with those of the semilunar, and with dislocation of the carpus, and thus form a whole series of varieties that can be described as radial complications of

the different carpal lesions, whereas in the first two cases the clinical appearance of the lesion of the radius is the predominant factor.

By uniting them into a single class, we shall be accustomed to look for them, and will see the important part they can play in the prognosis of carpal lesions.

There are very numerous forms of these partial fractures :

(1) Fracture of the tip of the styloid process of the radius.

(2) Fracture of both styloid processes :

(3) Fracture of the posterior lip with its different degrees :

    (*a*) Limited to the border only, or first degree :

    (*b*) Encroaching on the glenoid cavity of the radius, second degree :

    (*c*) Fracture of Rhea Barton, with typical displacement, or third degree, whereas in the two first degrees the wrist is not subluxated and the whole breadth of the posterior lip is not fractured :

(4) Fracture of the anterior lip with the two degrees noted in the preceding form, and the third or the fracture of Letenneur :

(5) Fracture of the two lips at the same time :

(6) Fracture of the base of the styloid process of the radius :

(7) **Y**-shaped fractures answering to the portion of the radius articulating with the scaphoid.

(8) Impaction of a spur of bone :

(9) Fracture of the scaphoid accompanied, rarely it is true, by fracture of the part of the radius articulating with the semilunar. We shall see also fracture of the semilunar can be associated with fracture of the part of the radius articulating with the scaphoid.

I do not wish to insist more on the pathological anatomy, a little too refined to have great practical value. I desire only to draw one conclusion : amongst all these types of

Fig. 19.— Fracture of the Upper Extremity of the Scaphoid.

Fig. 18.— Fracture without Displacement of the Middle Part of the Scaphoid.

Fig. 20.—Fracture of the Middle Part of the Scaphoid.

Fig. 21.—Fracture of the Base of the Scaphoid.

FIG. 22.—FRACTURE OF THE EXTERNAL COLUMN.

Fig. 23.—Fracture of the Scaphoid with Dislocation of
the Carpus.

FIG. 24.—OLD COMMINUTED FRACTURE OF THE SCAPHOID WITH ANCHYLOSIS.

FIG. 25.— FRACTURE OF THE SCAPHOID WITH POSTERIOR MARGINAL FRACTURE.

partial fractures of the radius, none are of no importance and without serious consequences : on the contrary, when we find a fracture of the upper extremity of the scaphoid combined with an alteration of the glenoid cavity of the radius, fracture of the point or base of the styloid, or the two degrees of fractures of the anterior or posterior lips, it is not rare to observe stiffness and loss of function passing on to anchylosis between the radius and the scaphoid and between the former and the semilunar, and it is often in these complications in the radius that we must seek for the principal factors in the seriousness of carpal lesions which appear simple.

It has been much insisted upon that with injuries to the wrist, when the force has been exhausted in producing lesions of the carpus, there are no injuries to the radius : thus stated, the proposition is false, perceptible lesions to the radius should be added, for radiography shows, on the contrary, that the radius is often affected in lesions which appear to be purely carpal.

The great part the scaphoid plays is seen from the general review of the anatomy and pathology which we have only sketched. From a consideration of these facts we can place fracture of the scaphoid among the class of causative factors, and we will now study it in detail.

ETIOLOGY.—Fracture of the scaphoid is very frequent. Ross and Wibert consider it represents 9 per cent of all fractures. Mourgues finds amongst 61 fractures of the carpal bones :

43	fractures of the		scaphoid	70 per cent
8	,,	,,	os magnum.....	13·5 ,,
5	,,	,,	semilunar	8·5 ,,
3	,,	,,	cuneiform	5 ,,
1	,,	,,	pisiform	1·5 ,,
1	,,	,,	trapezium and trapezoid..	1·5 ,,

Up to the present time I have personally taken 150 plates and seen more than 220 cases in consultation. My statistics for the other lesions are :

24 fractures of the semilunar :
90 dislocations of the carpus :
4 fractures of the trapezium :
8 fractures of the cuneiform :
1 fracture of the base of the os magnum.

Fracture of the scaphoid is met with at all ages, but especially from 18 to 50 years of age, and in preference in men, who are more exposed to injuries than women.

All professions pay tribute to it, gymnasts more particularly, and Kauffmann has found many cases in the gymnastic club.

Falls on the hand extended rather than flexed are most often the cause. Driving back the hand by the handle of a tool, by a clumsy blow with a hammer have also been blamed.

I have had the opportunity of observing fracture of the scaphoid on two occasions in both wrists.

The first occurred as a result of a fall from a horse, the second from a motor-cycle.

I have seen fracture of the scaphoid result from a direct blow three times, namely, from the recoil of the handle of an automobile. The handle had clutched, and the chauffeur wished to stop it, and received the blow on the root of the thumb.

Bosquette has noted also a curious case. In a young boy a blow from a bill-hook divided at the same time the tendons of the anatomical snuff-box, the styloid process of the radius and the scaphoid. The author made a periosteal suture of the bone, and then reunited the tendons : the result was excellent. The anatomo-pathological forms which fracture of the scaphoid shows are quite distinct. I do not speak of fragmentary lacerations, small bony bits sometimes perceived after a sprain, but of true fractures implicating the body of the bone.

The fracture may be incomplete : my first case appeared to affect only the external half. Usually they are complete. Before describing the various forms of fracture I will call to mind great care must be taken in reading the radiogram. I have already mentioned the mistake I made in 1897.

The forms and appearances of the scaphoid are very various, according to the position of the hand and the calling of the patient, and uncertainty may exist between a plate showing a sprain and one a fracture of the scaphoid, as they have signs in common. It is the plate taken side view which settles the question. If there be any doubt, there should be no hesitation in taking another plate, changing the positions and especially by placing the hand alternately inclined to the radial and to the ulnar side. In former days the Germans described congenital scaphoids, which were divided into two or three parts. It is quite probable many of the congenital forms were only unrecognised fractures.

Fractures should be diagnosed only if they be quite plain, either from separation of the fragments or from irregular lines visible on the borders, following the shadow of the scaphoid, indicating riding or impaction of the fragments.

The line of fracture is very variable. Most frequently it passes through the middle of the bone, at the level of the contracted part, below the superior radial articular surface. It is nearly horizontal, and separates the basal portion spread out into the apophysis from the upper articular extremity : it is a little higher than the height of the semilunar, to which it often remains united.

It is irregular and dentate, sometimes bifurcated like a **Y**, leaving an isolated small fragment. I have never seen it like a **Z** (Hirsch).

Sometimes the site of the fracture is at the upper extremity and a small fragment is separated in the middle of the radio-carpal articulation. It seems to be only one fragment, whereas on opening the joint a number of cartilaginous bits are found, of which there was no suspicion from the radiogram. At other times, the line is at the base and the palmar apophysis is detached, following an irregular horizontal line, which appears cut perpendicularly over the clear space between the articulation of the trapezium and the scaphoid.

Usually, this lesion is combined with displacement of the trapezium, which is subluxated posteriorly, whilst the

apophysis is pushed inwards and forwards. Lastly, the scaphoid may show two lines, one above, and the other below, separating a middle part.

The lower portion may itself be broken into many pieces.

Very often the fragments are impacted and ride over each other, and this causes a difficulty in reading the plates. Often, also, the fragments remain in contact without displacement.

One of the frequent forms resembles plication of the bone, the fragments which are separated externally being impacted internally. The normal curve is exaggerated and the bone takes the form of a circumflex accent, or of a chevron forming an angle, with a sinus internally. This angle may be of various degrees : it is the lower fragment which is displaced internally, bringing with it the bones of the thumb. The carpal groove is then contracted, and it is not rare to note some signs of compression of the median nerve with simple anæsthesia, or the painful form most often of the thumb, and sometimes of the index finger.

Besides these displacements with exaggeration of the curve, we must note other different types. The most frequent is that in which the lower fragment tilts from before backwards. The fractured surface becomes prominent in the anatomical snuff-box, whilst the palmar apophysis slips anteriorly in its articulation with the trapezium. The upper fragment remains joined to the external border of the semilunar, or, on the contrary, is free and, so to speak, floating. Sometimes this fragment, having broken the posterior lip of the radius, itself protrudes on the dorsal surface.

Lastly, in fractures of the base and of the apophysis, the displacement of the lower fragment can be such that the trapezium appears abandoned.

As a matter of fact, of all these types of displacement the two most frequent should be remembered : a dorsal prominence in the snuff-box, and internal rotation of the same fragment, which it is important to know, because of the compression of the nerve which often accompanies it.

The combination with fracture of the semilunar and of the trapezium is very rare : that with the latter has been

taken for a Bennett's fracture. The pain and subsequent loss of function in the movements of the thumb make it serious. I have shown the part played by the combination with comminuted fractures of the radius, which can end in slow synostosis of the radius and of the scaphoid, or in permanent arthritis of the radio-carpal joint. Interesting from a pathological point of view is the association of fracture of the trapezium, of the scaphoid and of the base of the styloid process of the radius. The whole external column of the wrist is in this way implicated by direct transmission of the injury.
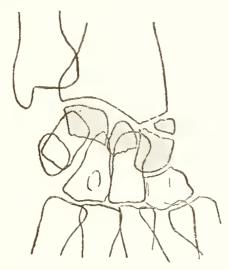
Fig. 26.—Fracture of the Scaphoid with Dislocation of the Carpus and Fracture of the Styloid Process of the Radius.

Mode of Production.—The theories which have been advanced to explain the method of production of these fractures are, like all articular fractures, two in number : crushing and laceration.

I have for a long time explained these fractures of the scaphoid, which are so common, by the shape and function of the bone.

My theory is simple : in fractures from a fall on the palm of the hand, the scaphoid is the most direct connection transmitting the weight of the body to the ground. By reason of its two bent axes, when the thenar eminence is leant upon, a bell-like movement is produced, which results in bringing the upper extremity of the bone posteriorly.

One of three things happens : either the scaphoid firmly
ensheathed and forming a mass with the carpal condyle
resists, and the radius breaks, or, on the contrary, the
position of the scaphoid is such that the force is con-
centrated on it, and then, in order to escape by tilting, it
breaks its upper extremity, on which no ligament is in-
serted, against the radius ; or again, as it is curved on the
flat, this curve becomes exaggerated, and it breaks from
increase of flexion. The distal fragment then continues
the movement and tilts posteriorly into the anatomical
snuff-box.
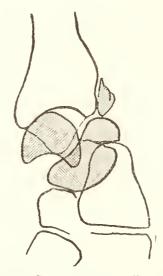
FIG. 27.—FRACTURE OF THE SCAPHOID WITH DISLOCATION AND POSTERIOR
MARGINAL FRACTURE.

Experience shows fracture occurs easily when the hand
is hyperextended and bent to the radial side, conditions
which fix the bone and prevent it escaping the injury.

Fracture from falls on the back of the hand is ex-
ceptional : it is also explained by the application of
physiology. The scaphoid is wedged under the radius and
cannot escape : it is broken by exaggeration of its curve.

SYMPTOMS AND DIAGNOSIS.—Fractures of the scaphoid
have few signs of their own, and that is why they have
for so long escaped the acuteness of clinicians. The rapid
swelling, limited to the anatomical snuff-box, is found in
sprains and even in fractures of the styloid process of the
radius.

Spontaneous pain, localised on pressure in the snuff-box, is not characteristic. Pain provoked by movement, especially to the radial side, is of more value, but is also a deceptive sign.

Crepitation and mobility of the fragments hardly ever exist. Their presence is a certain sign, and Malgaigne,
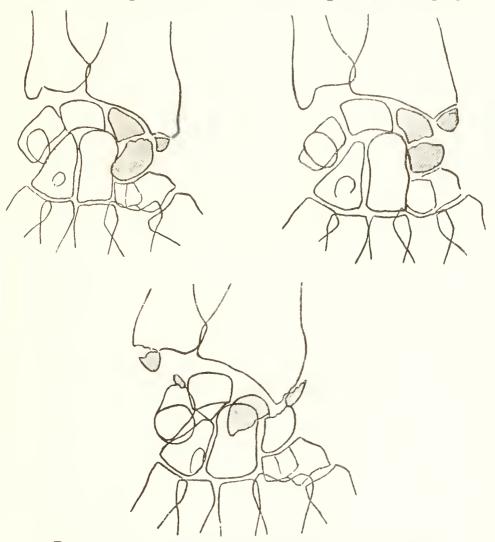
FIG. 28.—FRACTURE OF THE SCAPHOID WITH FRACTURE OF THE STYLOID PROCESS.

Cloquet and Jarjavay have already emphasised them: unfortunately their inconstancy is too great.

Diminution in the height of the wrist is also met with in scapho-lunary dislocation. Dorsal or diffuse ecchymosis

anteriorly in the thenar eminence has nothing patho-gnomonic.

Disturbances from compression of the median nerve are too inconstant for any account to be taken of them.

All the clinical signs are only presumptive, and this explains why the older clinicians, who had not the benefit of radiography, missed a lesion, the frequency of which appears to us to-day surprising.

Only crepitation, when it is to be felt in the snuff-box, the depression of which is filled by a hard swelling, has a positive value.

The diagnosis, then, is very difficult. Sprain and sub-luxation of the scaphoid and of the semilunar have the same clinical appearance. I have quoted the case of an army student, training in boxing, who suffered from a sprain as the result of a badly directed blow. The signs of fracture of the scaphoid had been made everywhere. Radiography confuted the clinical opinion.

Fracture of the radius with marked displacement, Pouteau's type, does not require consideration. It is not the same with partial fractures, the symptoms of which are very similar, and can be mistaken.

The other lesions of the carpus show some special appearances, on which we shall have to insist.

In every injury of the wrist attention ought to be directed to the scaphoid, for this bone is in the traumatic centre, and associated with other lesions its fracture can easily pass unnoticed.

A combination with fracture of the trapezium is one of those where the clinical diagnosis can be surmised, because it betrays its presence by pain and loss of function of the thumb, which is always very marked, and has been taken for Bennett's fracture.

It is, finally, of radiography we should ask for a precise diagnosis.

I have already shown, when studying sprain and diastasis of the scaphoid and of the semilunar, the difficulties in reading the radiogram, and I have insisted upon the different normal shapes the scaphoid can take.

Congenital divisions of the bone are rare, but must be

noted. Gruber, Pfitsner, Wolff, Auvray, Debiéne, Dujar-
rier and Schultz have described them. In a case described
by Barbarin ("Bull. Soc. Anat.," 1900), the scaphoid was
divided into two by a longitudinal line, but these cases are
exceptional, and most often the appearances seen are due
to old fractures with pseudo-arthrosis.

PROGNOSIS.—It is difficult to give a correct opinion on the
progress of these fractures.

If all the wrists of gymnasts be examined, it is surprising
to see how well fracture of the scaphoid has been tolerated.
A famous boxer had broken his scaphoid bones, and for
some months his swinging blows had lost their power : his
last victory shows his cure.

On the other hand, it is indisputable some fractures are
serious. They are followed by anchylosis of the wrist
with synostosis between the radius and the scaphoid.

The clinician is then in a state of perplexity.

Osseous consolidation between the fragments is ex-
ceptional. *Pseudo-arthrosis* is the rule, especially in fracture
of the upper extremity, which being separated forms an
intra-articular foreign body with subsequent arthritis :
it is a serious form.

In other cases, the fragments are impacted at one point,
and fibrous callus is produced, uniting and consolidating
the fragments.

The site of the line of fracture plays a great part in the
prognosis. Fractures of the upper extremity are more
serious than those of the base. The isolated fragment,
having lost its ligamentous connections, degenerates and
forms a foreign body.

Non-reduction of the fragments, the persistence of pain,
swelling, loss of function and diminution of strength are
very frequently observed.

In Reynard's thesis I have shown the prognosis ought
often to be reserved. The presence of comminuted fracture
of the radius aggravates still more the prognosis : syno-
stosis leading to arthritis may occur.

Complications connected with the trapezium also lead
to discomfort with pain and loss of power on squeezing.

The movements are always slightly limited, especially

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those of extension, and still more so on bending the hand
to the radial side.

Hence arise partial permanent incapacity, which can
in some instances vary between 10 and 40 per cent, accord-
ing to the degree of stiffness of the articulation and for the
side affected.

This incapacity, which is often reduced to 0 or 2 or 3 per
cent, will also be slight if anchylosis be slow and the mobility
of the fingers be preserved ; but inversely, a painful wrist
with even some mobility will be more than made good by
an immobile wrist. The difficulty in and pain on moving
the thumb, the presence of signs of compression of the
nerves are factors of which great notice should be taken.

Otto Blum, in 15 cases of isolated fractures, has seen
loss of function of the hand eight times.

Temporary incapacity varies from 3 to 6 months,
especially from occupational accidents.

Without going so far as to allow more than half of the
cases to be bad ones, as Otto Blum does, I think slight very
troublesome pains often persist, occurring suddenly from
movement, with always, or nearly always, weakness of the
muscular strength in seizing objects and on catching hold
firmly of implements, whereas, on the contrary, complete
anchylosis and absolute loss of the wrist are rather rare.

It is, then, very difficult to formulate an exact prognosis.
We must take note of the form of the fracture, simple or
comminuted, of its site, complications arising from the
radius or from the trapezium, of symptoms of compression
of the nerves, and lastly, the age, sex (women at the
menopause) and of the general state of health, all con-
ditions which can aggravate the prognosis.

TREATMENT. — In recent fractures the hand must be
flexed and forced to the ulnar side, pressing back at the
same time vigorously the prominence of the anatomical
snuff-box in front by applying the thumbs to the fragments.
The pieces are in this way moulded to the head of the os
magnum. A plaster application for ten days maintains
reduction.

When it is impossible to reduce the fragments and the
upper fractured extremity protrudes under the posterior

lip of the radius, and cannot be replaced, operative interference is indicated, followed by early active and passive movement. It is wise to be skilful in these matters. Generally, massage is abused. In articular fractures, rest, immobilisation, a cotton-wool pad, no impermeable apparatus, in order to allow of perspiration (paper is the simplest), easing the pain and removing the articular and periarticular exudation, are better than massage. The fluid being absorbed, slow and progressive, active and passive movement is much better than massage, which ought to be reserved for cases where the injured person suffers from muscular asthenia, and as an adjuvant, which must be watched very closely and only employed at the end of 18 to 20 days, when there is no longer any fear of irritation of the sheaths of the tendons or of the articular synovial membranes. Mobilisation will be earlier according as complications connected with the radius or with the trapezium are noted.

In old cases, where chronic arthritis, pain and loss of function exist at the end of some months, surgical intervention is indicated.

The removal of the upper fragment only (Hauffmann, Stimson, Codman and Chase, Ludloff, Sackur), complete removal of the bone (Hœfliger, Hirsch, Pagenstecher, de Quervain, Courtin, Jerusalem, Bérard) have been in turn recommended. An incision into the anatomical snuff-box, from the styloid process of the radius to the first metacarpal bone, will allow of the scaphoid being reached and resected.

Observers praise the results obtained. Abduction of the radius resulting therefrom appears to have no great influence on the function of the hand.

The cases I have been able to see after some months, appear to me to be less favourable than the authors say.

If the movements have returned, the strength is, however, much decreased, and often pains persist, limiting the movements more than a true mechanical obstacle. A mobile painful wrist is not as good as a good anchylosis. The mobility of the fingers is the most important factor from a professional point of view. Indication for opera-

tion will be drawn from the different factors and the calling of the patient, from the presence of sensory, motor and trophic nerve disturbances, but it should be known the nervous affections can disappear spontaneously at the end of more or less time.

There should, therefore, be no hurry to operate in simple cases. Operative indications can be drawn from the presence of a wound. I have quoted the curious case reported by Bosquette, who made a periosteal suture, taking advantage of a division of the tendons in the anatomical snuff-box.

We shall have to examine in another chapter the conduct to be pursued when fracture of the scaphoid accompanies luxation of the separated semilunar or a fracture of this bone.

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FRACTURE OF THE SEMILUNAR[1]

FRACTURES of the semilunar are relatively rare. I have collected 24 cases without having recourse to the literature.

Before the era of radiography it was rare to find any mention of this lesion, except as a curiosity. Since 1896, every author who has interested himself with the wrist has quoted isolated examples. In my book, on the " Poignet et les Accidents du travail," I have reported 2 cases. My pupils, Tavernier and Gaulier, in their thesis, and Chaput and Vaillant in the " Revue d'Orthopédie," have related some observations.

In Germany, without mentioning the true fractures which concern us, Kienbock was the first to note a lacunary and cystic condition with separation of the diarthrodial cartilage, following sprains, and these said degenerations, which I had already noted as such for a long time, and which show themselves by a mottled condition either of the semilunar, of the scaphoid, or of the os magnum, have been published as fractures of the semilunar. I hold a reserved opinion on this point, not having had the opportunity to remove such bones, and the side views of the plates have not shown the typical flattening of fractures of the semi- lunar : the cysts and raising of the cartilage can be inter- preted in different ways and not as fracture.

I think I am able, if not to describe the complete history of fractures of the semilunar, at least to note the principal points in their history as a result of the 24 cases I have seen.

These 24 observations comprise 21 personal plates, one case unedited by Tanton, the case of Tassin of Dijon, which he was kind enough to report to me, and lastly, the case of Viallet of Algiers, to which I am indebted to the " Dauphiné Médical," where the case is published.

These 24 cases can be divided as follows :

(1) Isolated fracture of the semilunar : the accessory lesions are of little importance : 10 cases, one of which was a vertical fracture.

[1] A study by Destot on this subject with the same material has already appeared in the Paris " Médical " in 1914.

(2) Fractures of the semilunar and of the scaphoid, 4 cases.
(3) Fractures of the semilunar and intra-articular fracture of the radius, 4 cases.
(4) Fractures of the semilunar and extra-articular fracture of the radius, 2 cases.
(5) Fractures of the radius, of the scaphoid and of the semilunar, 3 cases.
(6) Fractures of the semilunar, of the scaphoid, and of the styloid process of the radius, with palmar luxation of the cuneiform, 1 case.

We will make some remarks on these cases.

Isolated fractures are more numerous : they can be divided into two varieties : one where the lesion is pure, and where, however, the semilunar has absolutely lost its connections with the scaphoid : clinically this is a simple sprain. In the other, which is more numerous, the scaphoid has no longer its normal connections : it has tilted and changed its shape, and we may note for the height of the wrist to be decreased it is necessary, when the semilunar is flattened, for the scaphoid to tilt or break, or, lastly, for the radius by breaking to allow the carpus to ascend.

This second form is closely related to dislocation of the carpus. Clinically, however, the differential diagnosis is difficult.

Fracture of the styloid processes are accessory.

In the forms where fracture of the scaphoid exists, it will be noted, in the majority of instances the fracture is one of the base of the bone : sprain of the joint between the scaphoid and the trapezium is frequent. This depends on the method of production of these lesions which follow a blow on the palm of the hand from the handle of a tool, from a hammer or from a pick-axe, owing to the excessive vibration of the handle by a blow out of the perpendicular.

It can be noted, moreover, all these lesions, apart from isolated fractures, closely approximate the complex lesions anatomo-pathologically present in dislocation of

FIG. 29.—OLD FRACTURE OF THE SEMILUNAR AND OF
THE SCAPHOID.

the carpus : there is only one different element, viz. fracture in place of dislocation of the semilunar. In the first case, the semilunar is fixed by the muscular contraction and cannot escape in front in the other, the semilunar has become enucleated, and we shall see from a clinical point of view the symptoms are so related that it is often not possible for a doctor, well versed in these questions, to make a diagnosis without radiography.
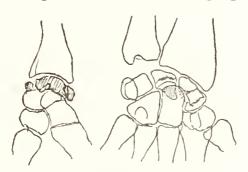
FIG. 30.—FRACTURE OF THE SCAPHOID AND OF THE SEMILUNAR.

FIG. 31.—DOUBLE MAR-GINAL FRACTURE WITH DORSAL LUXATION OF THE DEFORMED SEMI-LUNAR.

FIG. 32.—FRACTURE OF THE SEMILUNAR ACCOM-PANIED BY SPLITTING OF THE RADIUS.

The anatomo-pathological mixture of lesions we have just considered divide themselves into three clinical classes : (1) Sprain : (2) Dislocation of the carpus : (3) Fracture of the radius. This is tantamount to saying fracture of the semilunar has few or no symptoms of its own, and this is not surprising, if we remember this lesion had escaped observers before radiography. The mask is all the more impenetrable, as some small intra-articular fractures of the radius without symptoms, hiding a fracture of the semi-

lunar, end in anchylosis of the wrist, whereas an extra-articular fracture with great displacement may be less serious, notwithstanding its appearance.

I. FRACTURE OF THE SEMILUNAR, THE SPRAIN TYPE.—In this first class, the fracture of the semilunar is completely hidden. The accident has been a mild one, and it is not

FIG. 33.—SYNOSTOSIS BETWEEN THE RADIUS AND THE SEMILUNAR. THE SCAPHOID IS COMPLETELY TILTED.
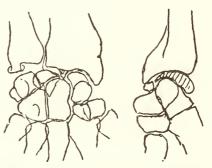
FIG. 34.—BI-STYLOID AND ANTERIOR MARGINAL FRACTURE: SEMILUNAR LUXATED AND FLATTENED.
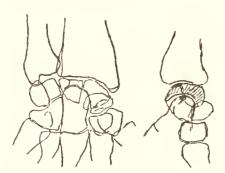
FIG. 35.—SCAPHOID AND SEMILUNAR FRACTURED. THE SCAPHOID IS BROKEN AT THE BASE.

FIG. 36.—FRACTURE OF THE SCAPHOID, OF THE SEMILUNAR AND OF THE STYLOID PROCESS OF THE RADIUS. THE FRACTURE OF THE SCAPHOID IS COMMINUTED.

rare to find the injured person has returned to his work at once or after one or two days' rest: but some slight pains and a little discomfort remain, and three or even six months after the accident the patient becomes uneasy at the persistence of these symptoms, and goes to consult a doctor. All that is found is a slight limitation in movement, a slight swelling in the snuff-box, a little antero-posterior thickening on pinching the semilunar between the

thumb and index finger, whilst relaxing the flexor tendons, by flexing the hand, and pain produced either spontaneously on movement, or passively. A rheumatismal, a tubercular or gonorrhœal affection is thus thought of. Sometimes, regular increase of the pains and of other symptoms warns the patient, and on consultation he is found to have a nearly complete anchylosis (Viallet's case), but this is not the rule.
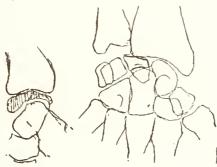
FIG. 37.—ISOLATED FRACTURE OF THE
SEMILUNAR. TANTON'S CASE.

FIG. 38.—ISOLATED VERTICAL
FRACTURE OF THE SEMILUNAR.
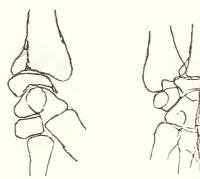
FIG. 39.—FRACTURE OF THE RADIUS, OF THE SEMILUNAR, OF THE
SCAPHOID, OF THE TRAPEZIUM AND OF THE TRAPEZOID.

II. FRACTURE OF THE SEMILUNAR, DISLOCATION TYPE.— In this case the objective signs are more marked. The wrist is diminished in height, and we have observed this new sign is as well seen with an isolated fracture with tilting of the scaphoid, as with fracture of the scaphoid and of the semilunar, or of the radius and of the semilunar, or of the radius, of the scaphoid and of the semilunar. Antero-posterior thickening of the wrist, limitation of the antero-posterior and lateral movements, a globular wrist, a prominent snuffbox, the head of the os magnum against the posterior

border of the radius make up the signs of dislocation of the carpus, but three chief signs are wanting ; two very important by reason of their constancy, the other of less value, because of the variability of its presence.

(1) In every dislocation of the carpus, if slight palmar flexion be possible, dorsal flexion is in its turn prevented, the wrist is locked on attempting this movement. In
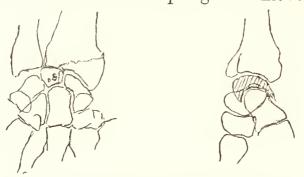
Fig. 40.—Fracture of the Styloid Process of the Radius and of the Semilunar ; Lacunary Condition of this Bone.
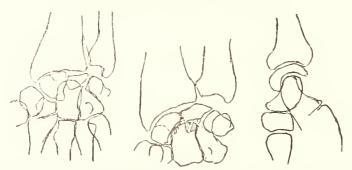
Fig. 41.—Isolated Fracture of the Semilunar with Subluxation of the Scaphoid and of the Semilunar.

Fig. 42.—Isolated Fracture of the Semilunar.

fracture of the semilunar, on the contrary, slight dorsal flexion can occur : the wrist preserves a certain amount of mobility.

(2) In dislocation, a prominence is distinctly felt in the carpal groove, answering to the luxated semilunar. On slightly bending the hand, the semilunar can be felt protruding in the fold resulting from flexion of the hand. In fracture, the wrist is distinctly thick, but if the luxated bone be searched for, there is only an indistinctly perceptible thickening.

(3) The nervous disturbances from compression are the rule in dislocation : the median or the ulna nerve, or both, are usually affected and are the cause of different symptoms : painful anæsthesia, formication, etc. : In fractures, on the contrary, these symptoms are exceptional.

Excluding these signs which are difficult to perceive, the two affections have the same appearance. Perhaps etiology will be able to provide another diagnostic element,
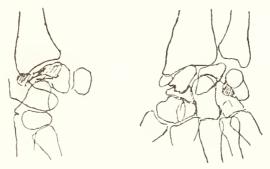
FIG. 43.—FRACTURE OF THE SCAPHOID, OF THE SEMILUNAR, OF THE STYLOID PROCESS OF THE RADIUS AND SUBLUXATION OF THE CUNEIFORM.
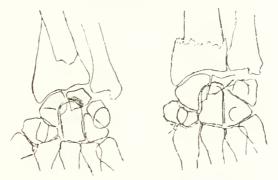
FIG. 44.—EXTRA-ARTICULAR FRACTURE OF THE RADIUS AND OF THE SEMILUNAR.

fractures of the semilunar being met with in people who use the hammer—carpenters, locksmiths, farriers, blacksmiths, quarrymen wielding pick-axes—boxers (1 case). The handle of a tool is held with the whole of the hand, and if the blow be badly applied, vibration is produced in the handle. In dislocation, the cause is most often a violent fall from a horse, or from a bicycle, etc. : but it can be understood how uncertain is the foundation for the views just suggested.

There is then a very great contrast between the intensity of the injury and the complexity of the lesions observed. It is one of the most remarkable points in their history, and this fact also explains why, at the beginning, the practitioner pays little attention to these slight injuries.

Their evolution is not regular. Usually, if some pain persist, if the movements of the wrist be limited, at least the patients can continue to work. A farrier could work
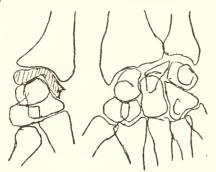
FIG. 45.—ISOLATED FRACTURE OF THE SEMILUNAR WITH SUB-LUXATION OF THE SCAPHOID AND OF THE SEMILUNAR.

FIG. 46.—ISOLATED FRAC-TURE OF THE SEMILUNAR WITH SUBLUXATION OF THE SCAPHOID AND OF THE SEMILUNAR.
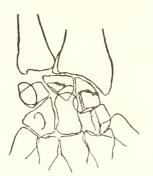
FIG. 47.—FRACTURE OF THE SCAPHOID AND OF THE SEMILUNAR. THE SCAPHOID IS BROKEN AT THE BASE AND IN ITS MIDDLE.

two hours consecutively, then had to rest before continuing his job. The patient, a stone-cutter, of Dr. Tassin returned to his work with an incapacity of 20 per cent. On the contrary, in Viallet's patient, anchylosis resulted. In all the cases, where I had proposed an operation, the patients preferred their wrist to remain in its existent condition, although some of them were not protected by insurance.

It is difficult to judge the question of gravity. In Germany, the patients are docile and submissive. In France, it is not the same.

I have not had the opportunity of seeing recent cases and that explains itself. At the commencement, patients pay no attention to their injuries, which they consider insignificant. Without radiography, the doctor has not made a diagnosis. It is the persistence of the pains, or the excessive loss of function, which decide upon the use of radiography. The Germans have resected the semilunar, and state they have had good results. I think active and passive movement, douches of hot air and all the small measures which gain time, allow the patient to tolerate a slight infirmity, and it would be interesting to compare, whilst eliminating all obvious causes of error or not, the results obtained from intervention with those from abstention. Too often a result is declared good before time confirms it, and. on the other hand, there are some people who are content with little and are always satisfied with their results.

I believe it is necessary to be eclectic : mobilise immediately and try to obtain a cure by simple measures. If, in spite of everything, treatment does not improve the patient, we are warranted in resecting the semilunar. It is usually a simple operation, which is made more difficult in this type of case, because the flattened bone overlaps in front and behind, and its bed is reduced in size. The incision is that for resection of the wrist.

III. FRACTURE OF THE SEMILUNAR AND OF THE RADIUS. —We must distinguish many types :

(1) Isolated fracture of the semilunar, with marginal fracture or infraction of a part of the glenoid cavity of the radius.
(2) Fracture of the semilunar, of the scaphoid and cracking of the glenoid : radio-scapho-lunary type.
(3) Fracture of the semilunar with intra-articular fracture of the radius.

Of these three forms, the two first are serious and can be

joined into one group, the two varieties of which would represent two degrees.

In the first the injury is insignificant, the lesion appears of no importance, but it progressively ends in anchylosis of the wrist. The symptomatology is very obscure and the lesion of the radius gives rise only to localised pains, without great swelling or typical deformity : it is almost a sprain in which radiography shows a comminuted fracture of the radius.

The radio-scapho-lunary type, on the contrary, is a fracture of large fragments which presents at the same time signs of fracture of the radius, and carpal lesions.

The third form is, strictly speaking, a fracture of the radius, and the lesion of the semilunar is unrecognised. Clinically, only a simple extra-articular fracture of Pouteau is seen : it is treated as such, and it is very astonishing to find on removal of the apparatus, pain, loss of function and limitation of movement : in one word, serious signs which would be attributed formerly to fracture of the radius, and which, in reality, depend on an unrecognised fracture of the semilunar.

In the two first forms, the question of immediate intervention arises. In the last, on the contrary, the fracture of the radius must be reduced, the bone moved early, and the semilunar removed secondarily, if loss of function and persistent pain be present.

In one word, when fracture of the semilunar co-exists with intra-articular fracture of the radius, intervention is the rule ; on the contrary, when the fracture of the radius is extra-articular, we can wait and conduct the treatment according to the result obtained.

In these three forms the first is deceptive, the second leaves no doubt : as to the third, it is a fracture of the lower extremity of the radius, with a fracture of the semilunar, but the radius is predominant, and the fracture of the semilunar is completely concealed by the symptoms of fracture of the former. It can be seen from this survey how much fractures of the semilunar are masked : the analysis of the radiogram shows the complexity of the lesions which accompany them, but, from the clinical

point of view, all these details disappear and give rise to quite a different symptomatology.

If the fracture of the radius we have last considered occupy the whole picture and hence there be no suspicion of the lesion of the semilunar, on the contrary, we are on our guard in the second form, because the lesions of the radius are very marked, and at the same time the carpus is changed in shape and general appearance. In these two cases the injury has been considerable, and consequently the fall and tumble attract the attention. But it is not the same in the first form, or in the sprain type, and if we endeavour to make a diagnosis from isolated fracture of the scaphoid, we shall be regularly deceived if no plate be at our disposal. Again, tuberculosis is not in its early stage easy to eliminate. Do not patients always recall an injury ?

Fortunately, the plate's front view and in profile settle the difference.

We often meet in intra-articular fractures of the radius, accompanied with sprain of the scapho-lunary joint, secondary tilting of the semilunar showing this bone has followed the adjacent radius. In the plates, front view, the mistake is easy to make and a fracture of the semilunar might be thought of, if we do not possess a plate in profile, when the form of the semilunar, like the slice of an orange, shows its integrity and its displacement. The best proof is given in the discussion on the fracture of Kienbock. When at the same time as the mottled appearance we find the profile shows its shape has been altered, and it has become flattened, the case admits of no doubt : in the opposite case it is necessary to be cautious, all the more as this lacunary appearance is met with in other bones of the carpus without our being able to admit the presence of a fracture. It is not rare to see, as a result of a simple sprain of the semilunar and of the scaphoid with separation of the two bones of the scaphoid, characterised by tilting, a large and indistinct space between them : the external lateral surface of the semilunar instead of appearing as a single border, shows a part of this surface, and the trabeculation of the bone is clouded where the bone is difficult to recognise. If the patient be seen two or three months

afterwards, it is not rare to find the trabeculation entirely altered, lacunary and mottled, and I personally look on this condition as a degeneration, every time I find on side view the typical form of the semilunar like the quarter of an orange. I do not think all the cases shown by the Germans, especially by Baum in 1913, ought to be described as fracture ; without the control of the profile, and examination of the pieces removed, my conviction is not weakened.

The history of fractures of the semilunar I have just tried to sketch has a great practical interest. These unrecognised fractures explain many of the persistent disturbances, as pain and loss of function which we did not know how to classify, and as regards occupation accidents this conception has a certain value.

Theoretically, the connection of fracture of the semilunar with other lesions of the carpus, as sprain and dislocation, is very close, and we regularly see the same train of accessory lesions as a necessary accompaniment, as fracture of the scaphoid, tilting of the bone, lesions of the glenoid cavity of the radius, etc. Fracture of the semilunar gives the name and characteristic to the lesion ; it is a part of the lesions of the scaphoid and of the semilunar, which are interposed between the radius and the mass formed by the carpus and the metacarpus. In the case considered, the hand not being hyperextended, and the blow falling on the palm, with the hand contracted, the semilunar cannot become enucleated, and breaks, whilst becoming flattened, and all the sequlæ of the other lesions appear in order to compensate for the sudden loss in the height of the wrist. There is then a close connection between all the lesions of the scaphoid and of the semilunar, and if they all be collected into a whole, fracture of the semilunar takes its place in the series and demonstrates the physiological rôle of the scapho-lunary system.

Fig. 49.—Fracture of the Semilunar. Sprain Type.

Fig. 48.—Fracture of the Semilunar. Sprain Type.

Fig. 50.—Fracture of the Semilunar. Dislocation Type.

Fig. 51. Fracture of the Semilunar, Dislocation Type.

FIG. 52. FRACTURE OF THE SEMILUNAR. DISLOCATION TYPE.

FIG. 53. OLD FRACTURE OF THE SEMILUNAR.

FIG. 54.— FRACTURE OF THE SEMILUNAR AND OF THE STYLOID
PROCESS OF THE RADIUS

FIG. 55.— FRACTURE OF THE SEMILUNAR.

FIG. 56.—VERTICAL FRACTURE OF THE SEMILUNAR.

Fig. 57.— Dislocation of the Carpus with Fracture of the Scaphoid (1st stage).
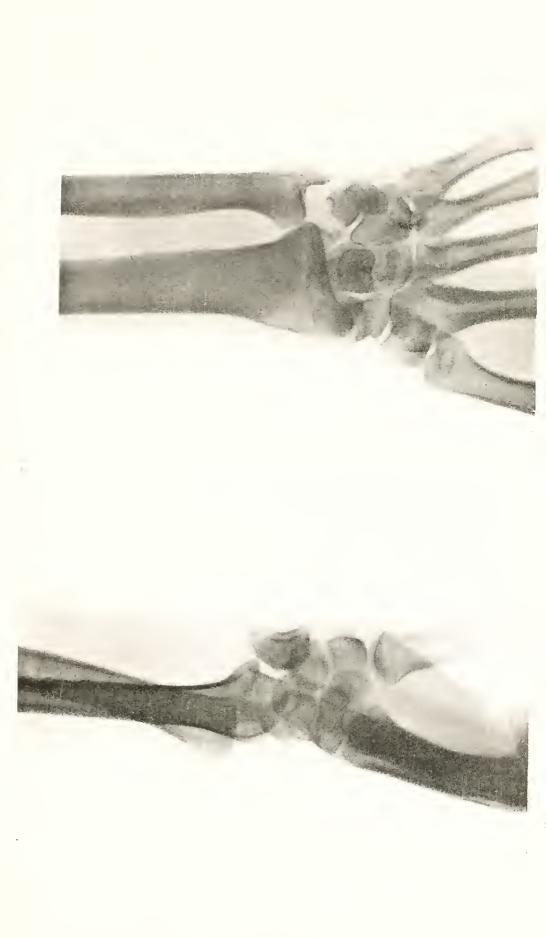
FIG. 59.—DISLOCATION OF THE CARPUS WITH ENUCLEATION OF THE SEMILUNAR.

DISLOCATION OF THE CARPUS

UNDER this new and concise name I have described a peculiar anatomo-pathological mixture of lesions, the very characteristics of which depend upon the special anatomy and physiology of the first row of the carpus.

The preponderating characteristics of one type of affection can be drawn from an infinite variety of lesions grouped under a single clinical class. Displacement of the semilunar from the os magnum is the chief and constant fact, but this dislocation is not produced without lesions of the scaphoid, and although my pupil Tavernier only sees in the tilting of the scaphoid a secondary process, the constancy of lesions of the scaphoid as fracture or luxation constitutes a factor inseparable from displacements of the semilunar. The converse is not true, since fractures of the scaphoid may be isolated and since lesions of the radius are also accessory and common to isolated fractures of the scaphoid and of the semilunar.

If the scaphoid had the form and shape of the semilunar, and if the longer ulna were in direct contact with the cuneiform, it is quite certain dislocation of the carpus would become a mid-carpal dislocation, analogous to sub-astragaloid dislocation of the foot. So also, if the first row lost its connection both with the glenoid cavity of the radius and with the second row, the luxation of the first row would be double, similar to double dislocation of the astragalus. But, on the other hand, the scaphoid elongated as an external splint, maintains its height and connections with the two rows, and, naturally, every effort of diastasis in the mid-carpal joint recoils on it : on the other hand, its curve and double angular axis always tend to tilt it backwards, whilst the semilunar which is not kept in place by any osseous support glides over the head of the os magnum, most often in front : hence the different luxation, typical of the carpal condyle, which seems to me to be the best characteristic of lesions of the scaphoid combined with luxation of the semilunar.

Isolated displacement of the semilunar, without luxation or fracture of the scaphoid, is never seen.

As far as the cuneiform is concerned, it is far from the ulna and its lesions are insignificant compared with those of the scaphoid and of the semilunar.

Are not theorists struck by finding the slight participation of the cuneiform in lesions of the carpus implies the necessity of a direct action of the bones of one part on the other ? Are not the partisans in favour of laceration astonished that traction by the ligaments does not break the cuneiform as well as the scaphoid ? The ligamentous bundles which are considered to play a part in fracture of the semilunar and of the scaphoid tear away the styloid process of the ulna but have no action on the cuneiform. An enormous force is necessary for fracture or luxation of this bone, and capable of approximating it to the ulna, or such a position of the hypothenar eminence that it is especially injured, as in Brossard's experiments.

At the beginning of my researches, I called this lesion mid-carpal luxation, and there are to be found in the "Province Médicale" of 1898, three observations designated mid-carpal luxation.

If the displacement of the semilunar had been only mid-carpal, I should have kept to this title, but unfortunately, usually the dislocation of the semilunar is in the radio-carpal joint. Whenever it is entirely a simple rotation on its transverse axis, so that its cornua look below or in front, it is of no importance, and I do not quite understand why Lesser insists on the degrees of rotation. But the radio-carpal dislocation is much more important. Usually, the semilunar, suspended or not by the anterior ligament, leaves the glenoid cavity of the radius, and this frequent enucleation is against maintaining the term, mid-carpal dislocation.

As to the name, dorsal luxation of the os magnum, this is grammatically correct, if there be added :

(1) With fracture or divergent dislocation of the scaphoid and of the semilunar :

(2) With luxation of the cuneiform and of the semilunar : because it must not be forgotten, the semilunar is often found quite free, having lost its connections

(*a*) with the os magnum : (*b*) with the glenoid cavity of the radius : (*c*) with the scaphoid : (*d*) with the cuneiform : whilst the os magnum itself has only completely lost its connection with the semilunar, and partly so with the scaphoid.

Lastly, on operating, when it is a matter of reduction or resection, it is the semilunar which is the objective and not the os magnum. The clinical argument does not hold. In the so-called dorsal luxation of the os magnum, there is no protrusion of the head of this bone elevating the skin, the hand is extended on the forearm, the fingers are half flexed, the wrist locked and the head of the os magnum is felt under the posterior border of the glenoid cavity of the radius. Lastly, it is necessary to be on one's guard in reading the radiograms and to know if they have been taken with the radial or the ulnar border against the plate. In the latter case, a deformity will be noted.

This discussion is, moreover, quite unnecessary : the essential thing is to understand the lesions we lay claim to designate, without desiring to give them a pathogeny, and a method of production which do more credit to the imagination than to the sagacity of the observers.

To consider facts only, we shall have to describe two groups of lesions :

(1) Dislocation, the most frequent condition.
(2) Mid-carpal luxation which includes the cuneiform and only comprises a few cases. It is usually dorsal. There are only two cases of palmar luxation, those of Gouilloud and Arcelin, and of Mouchet and Vennins.

I.—Dislocation of the Carpus, properly so-called.
It includes a large number of facts often apparently contradictory, but the chief factors of which are constant.

The pathological anatomy rests on : (1) radiograms : (2) autopsies : (3) the facts obtained from operation. These three sources are of unequal value.

Radiography is responsible for a certain number of errors in reading and technical faults which are the causes

of false conclusions, and lastly, it does not reveal the condition of the soft parts.

There are three autopsies : Maisonneuve, 1851 : Servier, 1880, and Fourgues, 1887. There are no particulars of the pieces from St. George's Hospital, mentioned by Holmes.

It is very difficult to judge of the information obtained from surgical operations. If Berger and Gross believed they could build up a pathogenetic theory founded on the state of the connections of the ligaments, those who, on the contrary, have operated with an open mind, have seen such variations in the state of the ligaments, that it is impossible to rely on these findings. I personally have operated on three old cases, and confess, notwithstanding a minute dissection, it was impossible to find the ligamentum arcuatum : in one case, the semilunar moved transversely, and was free, surrounded by new tissue : in a second, operated upon with Gallois, the semilunar was held down deeply by its posterior cornu, the anterior being free ; and in the third, it could be removed by itself, after division of the anterior fibrous tissues in which nothing was recognisable. I do not believe in the positive value of these surgical findings, all the more so, as I have assisted at other operations (Vallas, Tixier, Siraud, etc.), and each time the surgeons were much perplexed to interpret the nature of the bands holding the semilunar in position. On the other hand, much too much reliance is placed on the ligaments, which theoretically ought not to break, but yet are found torn ! Tearing of the lips of the glenoid still more complicate the question. To sum up, I consider the information obtained from operation varies very much, and its inconstancy removes all value as far as determining the pathogeny.

Lastly, experimentation. On this point also I am very sceptical, for although the experiments of Lilienfeld are very remarkable, those of Tavernier, confirming them, show everything is not the same on the cadaver, as during life, and the types reproduced are not absolutely the same. The study of an experimental fracture cannot take the place of an autopsy of a real injury, and the latter is rarely possible.

The variety of the lesions and their complexity is great : that is why it is a good thing to arrange them according to their chief symptoms. Dislocation of the semilunar being the principal factor, we will describe :

- (a) Lesions in which the semilunar has left the head of the os magnum only (first stage).
- (b) All the cases in which the semilunar has left both the os magnum and the glenoid cavity of the radius (second stage).

This double dislocation has many stages easier to read in the radiogram than to describe. Rarely, the semilunar is luxated and broken at the same time (Durand).

The concomitant lesions of the scaphoid are easy to describe, and they are readily followed on the plates :

- (a) The scaphoid is subluxated posteriorly.
- (b) The scaphoid is broken and its upper extremity accompanies the semilunar : rarely its fracture is comminuted.
- (c) The scaphoid is seldom dragged in front with the semilunar and torn from its bed in the trapezium (personal case, Hurpy's case).

The lesions of the radius are accessory, and we find here also fractures of the tip of the styloid process, of the base of the styloid, of both styloids, spur-like fracture, a **Y**-shaped scaphoidal fragment, a semilunar fragment, fracture of the anterior lip of the radius without displacement with its two degrees, fracture of the posterior lip with displacement with its two degrees and fracture with anterior and posterior fragments. We reserve for a special chapter complications connected with the cuneiform and with the os magnum.

A. First group, first stage : the semilunar does not fit into the head of the os magnum, but has kept its orientation, or has tilted on its transverse axis and its cornua look below and in front. The os magnum has preserved all its connections with the other bones of the carpus. The scaphoid has subluxated on to the external surface of the os magnum, either entirely if it have tilted,

or the inferior fragment if it be broken. In this case its upper fragment has passed in front with the semilunar, or has subluxated posteriorly outside the styloid process of the radius, or again it has dislocated posteriorly, above the posterior lip of the radius.

What is the condition of the ligaments? The capsule may not be torn : usually it is opened transversally, as the autopsies of Servier's and Maissoneuve's cases show. The lateral ligaments are intact. The semilunar has kept its attachments to the ligamentum arcuatum, but the scapho-lunary ligaments and those between the cuneiform and the semilunar are torn. It is the only form which has been produced experimentally by Lilienfeld and by Tavernier. It is this simple form that can be best discussed.

B.   In the second group, second stage, the semilunar is dislocated from the radius and from the head of the os magnum. The semilunar, enucleated in this way, allows the second row to be placed in the prolongation of the axis of the forearm, whilst in the first group it forms a slight dorsal prominence. The dorsal deformity of the wrist is, therefore, more marked in the first than in the second stage.

Von Lesser, Tavernier and Delbet consider the degree of rotation of the semilunar on its tranverse axis ; is it 90 degrees or 180 degrees ? in order to find out if the ligamentum arcuatum be torn or not. I have already mentioned the practical difficulties of recognising these conditions. All the other ligaments have given away. More than that, cases occur where these well-known ligaments seem to have been the first to have yielded, and why should they not do so as well as the anterior lip of the radius ? Is it for the dogmatic reasons drawn from the experiments made in the Laboratory of Mines, on the resistance of the bone and of the ligaments ? An ever-lasting question to be found in every history of articular fractures, and which ordinary good sense is sufficient to decide, because, after all, there are many pure dislocations where the ligaments, however strong they may be in the cadaver, are found to be weaker in the living than the bones.

I have seen 3 cases where the semilunar has slipped, so to speak, over the anterior surface of the os magnum. The sharp border of the anterior lip of the radius was clearly felt. It is a recurrent form to which I will return.

Gross and Tavernier have been compelled to allow in this case a palmar luxation of the semilunar.

Codman and Chase and Lembke have seen similar cases, which greatly perplex the partisans of the ligamentous theory, and which are, however, explicable by those, who, like myself, only attribute a very secondary importance to it.

The ligaments being torn, the semilunar is free and can then take the most peculiar positions. It has been seen on the anterior surface of the forearm and also through the skin (Albertin) : then why complicate a question which is sufficiently so already ?

At the same time as this dislocation occurs, compression of the nerves, which is generally absent in cases of the first group, is to be noted. These disturbances are met with in the median, or in the ulna, but anæsthesia dolorosa regularly observed after dislocation is not always a result of compression by the enucleated semilunar, but is also due to direct contusion of the nerves from the injury.

What happens to the scaphoid when the semilunar is dislocated ? We have said :

(1) It luxates on to the dorsal surface :
(2) It breaks and its lower fragment tilts posteriorly. The upper fragment follows the semilunar or luxates outside the styloid process of the radius, or behind. Fracture of the scaphoid may be comminuted (de Quervain) :
(3) It luxates in front with the semilunar : this is exceptional (personal case, Hurpy's case).

Excluding these special lesions, the scaphoid recoils on the radius. Small wounds are sometimes observed from the fall or a wound at the fold of flexure of the wrist, through which the semilunar is enucleated externally (Albertin, Forgues), or sometimes some small ulcerations on the dorsal surface of the wrist are visible. We must

mention in exceptional cases some lacerations, which must not be taken for fracture, of the cuneiform by the ligament between the semilunar and the cuneiform are to be found.

We must also note the rare combination of dislocation of the semilunar with fracture of the os magnum, of which there are one or two observations. All these series of lesions are met with in such various circumstances that it is very difficult a priori to believe in one pathogeny.
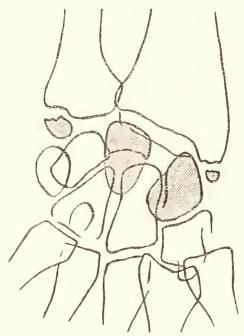
FIG. 60.—DISLOCATION OF THE CARPUS WITH FRACTURE OF
THE TWO STYLOID PROCESSES.

ETIOLOGY.—Dislocation is a relatively frequent lesion : I have seen about 150 cases.

Lilienfeld's statistics, which relate to 384 cases of fractures observed in three years from occupational accidents, include :

13 isolated fractures of the scaphoid.

5 dislocations.

1 fracture of the semilunar :

59 fractures of the radius, five with fracture of the scaphoid.

They are especially met with in adults from 16 to 50 years of age.

On children, juxta-epiphyseal separation is more frequent, as also bends or green-stick fractures of the forearm ; lesions of the elbow are still more frequent.

In old people, the fragility of the bones leads especially to fractures of the radius.

Dislocation is rare in women, who are less exposed to injuries. Above all, occupational accidents cause this condition : masons, carpenters, slaters, menders of chim-
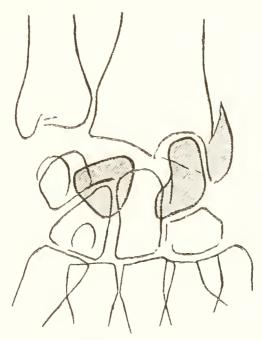
FIG. 61.—DISLOCATION OF THE CARPUS WITH SPUR-LIKE FRACTURE.

neys, who fall during their work, miners pushing a wagon and suddenly stopped or caught by a fall of coal : falls from a bicycle or from a horse, which explain its frequency in the army : chauffeurs from the recoil of the handle of an automobile.

I have seen a railway employé whose forearm was caught between the buffers of two wagons with the hand extended.

The lesion is more frequent on the right than on the left side. It is sometimes bilateral (Holmes, de Quervain, personal observation). The most curious case is the one observed by Prof. Quénu, that of a butcher-boy who

received from his master a kick behind which lifted him off the ground : he fell sitting, with both hands thrown backwards to deaden the shock : there was a double dislocation which was reduced. Usually, the patient does not know whether his hand was flexed or extended when he fell.

On the whole, the lesions are the result of indirect accidents, as falls or from being thrown on the ground. But, there are exceptions. I have seen a confrère, who, wishing to stop the handle of his automobile, which was out of gear, received a blow on the anatomical snuff-box which produced a fracture of the scaphoid with luxation of the semilunar. The condition was unrecognised, and operated upon one and a half months afterwards : the result was very bad.

Another method of its production was as follows : a workman was caught under a fall of earth, the handle of the pick-axe raised the mass of the carpus and of the meta-carpus, whilst the first row and the forearm were flattened against the ground : a dislocation occurred.

Here is a third case : some workmen placed a heavy pipe while casting in a trench, and in order to bring the pipe forward the four men together raised and pushed it. Three men let go and the last supported the whole weight, which twisted his wrist, without the hand touching the ground : dislocation was the result.

Lastly, I have reduced in Reclus' practice a dislocation in a man who, surprised at a corner of a street by a taxi-cab, endeavoured to avoid the blow by placing his hand on the radiator. He did not fall, but his right hand was driven back and hyperextended.

One or two observations have been reported, where dislocation occurred by itself, the hand being flexed into the palm (Wendt, Lilienfeld). These occurrences are doubtful.

I have seen, lastly, one case and Jaboulay another, where the hand was turned to the radial side, supported entirely on the thenar eminence. To sum up, observations show, excluding falls and tumbles, dislocation can be produced by a twist of the hand and by other means than

continued hyperextension with the hand flexed to the ulnar side.

METHOD OF PRODUCTION.—I must be very brief on this subject, because it is always possible to weave a small romance round the ligaments which resist or not, according to the needs of the case. I will confine myself to the actual experiments of Lilienfeld and of Tavernier. The physiology of the wrist had led Gallois and me to consider : (1) isolated fracture of the scaphoid required the hand to be hyperextended and turned to the radial side : (2) dislocation necessitated hyperextension with the hand to the ulnar side, allowing the scaphoid to be luxated posteriorly.

Examination decided my opinion on the first point, since I have been able to break the scaphoid alone experimentally once in three, in the position indicated, whereas Auvray (" Gazette des Hôpitaux," 1898) could only produce fracture of the scaphoid by a direct blow. But my second statement could not be borne out and I have multiplied my experiments in vain. I could only produce fracture of the radius or of the ulna.

Lilienfeld, in 1905, tried to imitate experimentally as completely as possible accidental falls and not direct blows. The following is the result of his experiments : he took an arm disarticulated at the shoulder, fixed the hand with bands in a determined position, then holding the limb firmly against his chest, he fell on the ground, representing as nearly as possible the normal condition. He concluded :

(1) Fracture of the radius is always produced if the limb be not quite perpendicular to the ground :

(2) A fracture of the scaphoid occurred if the hand were inclined to the radial side :

(3) A luxation of the semilunar and dislocation of the carpus with fracture of the scaphoid were the result, if the hand be inclined to the ulnar side.

I anticipated these occurrences for a long time, because the anatomical forms of fracture of the radius : the point or base of the styloid process, the spur-like fracture, and the scaphoidal fragment had indicated to me the stages

marked out by the successive positions of the scaphoid. Tavernier has repeated these experiments and succeeded on one occasion in producing, without preparation of the limb, dislocation of the first degree. These experiments are very important, especially when compared with my numerous negative results, and they explain the etiological facts I have reported. What, then, is the difference? In my experiments, the hand was firmly fixed by Brossard's apparatus, and had no play. On the contrary, in Lilienfeld's experiments, the hand on reaching the ground on falling did not then take a fixed course : it turned on its axis, with the result it broke the stability of the bone and of the carpal condyle, separating them, so to speak, and the pressure caught the condyle in the way of physiological dislocation. It is sufficient, in order to give support to this idea, to recall the observations in which dislocation is produced without a fall by torsion with maintained hyperextension.

Numerous theories have been proposed to explain the facts : Albertin (" Province Médicale," 1887), having seen enucleation of the semilunar through the skin, made some experiments to show this bone, the key of the arch of the wrist, when submitted to pressure, burst like a cherrystone into the palmar side, as it was the only way which remained open.

Potel admits luxation in both directions, palmar and dorsal ("Presse Médicale," 1899).

Berger believes adhesion of the semilunar to some bundles of the anterior ligament suggests laceration of this bone by excessive tension of this ligament is not out of the question in the production of articular displacement (" Bulletin de la Société de Chirurgie," 1893). Von Lesser has taken up again and developed the ligamentous theory, based on this hypothetical rôle. The experiments of Bialy (" I. A. Leipzig," 1902) were negative, but those of Lilienfeld, which I have reported, were positive (" Arch. f. klin. Chir.," 1905). M. Delbet goes still farther in support of the ligamentous theory. He discovered new ligaments, the action of which kept the semilunar in position and prevented it slipping whilst others broke the scaphoid by tearing it.

In the main, we must be eclectic, and I personally consider the function of the scaphoid and of the semilunar governs the whole question. When the hand is inclined to the ulnar side, the scaphoid can be luxated without breaking : when, on the contrary, the scaphoid is ensheathed, under the posterior lip of the radius, it will break and indent the radius which will show clearly the route it has taken.

The anterior ligament is very strong and the semilunar often remains attached to it on luxation, but it may be opened and the semilunar becomes free to pass on to the anterior surface of the wrist, on to the forearm and even through the skin.

The anterior ligament can be separated from the border of the radius and the semilunar slips in front of the os magnum.

In spite of the criticisms of Tavernier I do not think the lesions of the semilunar can be separated from those of the scaphoid, but I certainly allow, as Jaboulay does, dislocation does not require forcible bending to the ulnar side.

The succession of phenomena he indicates is very plausible : under the blow with bending to the radial side, the scaphoid breaks. The force being continued, the semilunar which is no longer supported becomes enucleated anteriorly.

I allow inversely, in hyperextension with inclination to the ulnar side, the semilunar, out of the perpendicular on the head of the os magnum, occupies the top of the carpal condyle and is more exposed to pressure. Squeezed, on the one hand, by the radius, pulled upon, on the other, by the tense ligament arcuatum, the semilunar enucleates : the scaphoid is then exposed like a tooth. If the bend to the ulnar side be insufficient, it escapes posteriorly without breaking, otherwise it breaks by exaggeration of the curve, and whilst tilting breaks the point or base of the styloid process of the radius and passes into the bone as a spur, or an angle of the scaphoid is removed.

All said and done, it is always the same thing, but in the opposite direction. They are the bones which act on each other, and the best proof is drawn from the frequency of

dislocation of the scaphoid and of the semilunar and of the rarity of lesions of the cuneiform.

The only point of importance to determine is the state of the anterior ligament, the integrity or laceration of which explains the irreducibility of the dislocation or its recurrence.   On this point, operations should give us information, but I have already said how difficult it was to form an opinion during an operation.   If, in certain cases, when the semilunar has passed through the ligament, it be nearly impossible to replace it, inversely, it can sometimes be reduced, although this method of treatment seemed at first as if it would not succeed.   This is why, in early cases, attempts at reduction ought to continue with set purpose as in dislocation of the shoulder, resection of the semilunar being a last resort.   It is quite astonishing how very easy it is to reduce the enucleated semilunar both in the radio-carpal and in the mid-carpal joint, and there are no practical means of knowing the causes of irreducibility of dislocation of the carpus.

Symptoms.—When a dislocation of the carpus has been seen and palpated, the diagnosis is easy, because the symptoms are usually very typical.   At the beginning, the functional disturbances are sometimes little marked.   A patient of Höfliger was able to work for nearly an hour after his accident.   I have seen five others of the same nature, one could remount his horse, another drove his automobile.   There is, so to speak, a momentary stupor, a feeling of uselessness in the limb, so that the injured person believes he has a simple sprain.   Thus, I have quoted the case of a confrère who did not suspect for a minute he suffered from the lesion that existed.   The slightness of the pain is, moreover, the special attribute of luxations : fractures are more painful.   But, usually, pains and loss of function show themselves afterwards, but are less acute than in a fracture of the radius.   It is rare at the beginning for dislocation to give rise to signs which trouble the patient. This explains why immediate reductions are relatively rare.

When there are disturbances, which are not constant, from compression of the nerves, the pains and formication

in the parts supplied by the median or ulna nerve bring
the patient to the doctor.

The deformity is a special one : the wrist is globular,
rolled on itself *with increase of the antero-posterior diameter
below the bi-styloid line and without any inclination to the
radial or to the ulnar side.* The hand prolongs the axis of
the forearm without a very clear or marked dorsal promi-
nence. The fingers are semi-flexed : there is no swelling
on the back or deviation to the radial side, the bi-styloid
line retains its obliquity. The wrist is as if it were locked :
if the fingers can be moved actively, the wrist is nearly
immobile.

Passively, sometimes very limited flexion can be obtained,
but extension is impossible.

Lateral movements are also very circumscribed.

Pronation and supination are restricted especially by
the pain.

Ecchymosis is exceptional : it is scarcely met with,
except there be a fracture, either of the borders of the glenoid
cavity of the radius, or of the scaphoid.

Palpation detects the disturbance of the bones of the
wrist. The obliquity of the bi-styloid line is usually
preserved. When the whole of forearm is embraced by the
hand, leaving the carpus to project, the whole swelling
is found to be situated below the styloid processes. If,
on the contrary, the carpus be caught, the hand stopping
at the bi-styloid line, no deformity is noted or any swelling
at the back in the anti-brachial part. Pain is usually
limited to the snuff-box, which is felt to be filled up by an
abnormal prominence.

The radial artery is felt superficially.

If the carpus be taken between the thumb and the index
finger, and the two sides compared, a considerable antero-
posterior thickening is perceived. We have described how
to measure the arch of the wrist, and it is easy to find the
necessary landmarks and to feel by palpation if the wrist,
shorter and globular to the eye, be really so. The head of the
os magnum may also be examined by the procedure I have
indicated, to see if it adjoin the posterior border of the
radius.

In dislocation, the internal and external heights of the wrist are diminished, but the external column only may be diminished in isolated fractures of the scaphoid, or the internal only in fractures of the cuneiform. The semilunar may also be felt in the carpal groove, raising the flexor tendons : it takes the form of a small bony mass, sometimes slightly movable, but most often fixed.

Complications either from fractures of the scaphoid or comminuted fractures of the styloid process of the radius or of the ulna usually pass unnoticed. All the anatomo-pathological variations we have described cannot be discovered on clinical examination.

The great clinical syndrome of dislocation of the carpus covers all anatomo-pathological varieties : we shall see how to differentiate it from mid-carpal dislocation, which is not always easy without the X-rays.

Dislocation rarely occurs with a typical fracture of the radius, most often the force is exhausted in the production of comminuted fractures which give no clinical sign.

But we can suspect laceration of the styloid process of the ulna when acute pain exists on the ulnar border at the level of the head of the os magnum : it recalls what is so often found in fractures of the radius and which is often more painful than fracture of this bone itself.

When the combination of a distinctly characteristic fracture of the radius with dislocation of the carpus is present, usually the carpus is not thought of.

We have mentioned the semilunar is sometimes enucleated externally : in this case, a small transverse wound exists in the middle of the anterior surface of the wrist, through which the bone projects, retained either completely or by one of its cornua by some ligamentous fibres. Forgues has drawn a typical case observed by him. These cases are very serious, because of the infection of all the tortuous articular cavities, badly opened and badly drained. Albertin had one death from tetanus, Hodges one from septicæmia, Buchanan had to amputate the forearm, O'Hara's patient was cured as by a miracle from pyæmia, specimens from Holmes' patient are in St. George's museum. Albertin, Körte and Malgaigne have, however, each had a

cure. These deplorable statistics, it must be noted, were before antiseptics, and Chaput ("Bull. de la Soc. de Chir.," 1914) in his communication shows we are now better armed against infection.

PROGRESS.—In old cases, different terminations may be observed. The most frequent is anchylosis of the wrist with trophic disturbances,[1] and complete loss of function. The first cases I saw were in this serious condition. But sometimes the patient recovers some movements in the fingers and even some dexterity when there has been no nervous compression. These cases correspond to the first degree of dislocation when the semilunar has not left the radius. Some patients nearly entirely recover the use of the hand, as my two observations prove, the one a cavalry officer who had fallen from his horse at Saumur, and who, Tavernier found five years afterwards, was capable of performing on the trapeze, of playing billiards and of fencing : the other, a woman whose arm had been amputated, could make use of her one dislocated wrist. Sometimes disturbing results are seen : a woman with an old dislocation and with anchylosis of the wrist without compression of the nerves received a new injury two years after her first accident. Immediately, pressure pains asserted themselves and necessitated a late resection of the semilunar, with a good result and recovery of function. A student of medicine, with a dislocation, was treated for a supposed gonorrhœal arthritis by injections of pure carbolic acid. Cure was obtained with semi-anchylosis.

When the lesion is old, formication persists and sensory and trophic disturbances are manifest if there be compression of the nerves : glossy skin, striated nails, circulatory affections, violet colour of the skin, hyperidrosis, spindle fingers, a true ulnar claw hand with atrophy of the interossei, or loss of the thenar eminence if the median be affected, may be found.

DIAGNOSIS.—This is very easy especially when one case has been seen, and it can be made at sight from a distance,

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[1] The trophic disturbances depend both on compression of the nerves and on osseous dystrophy (decalcification of the carpus and of the bones of the hand).

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so typical is the deformity. There is only one differential diagnosis to be made, viz. from fracture of the semilunar, which shows the same deformity, but then and always the distinction can be made by sight alone, for usually fractures of the semilunar, which are exceptional, do not fix the wrist as firmly as dislocation, and when the patient is asked to move the wrist, or we try to do so, slight dorsal extension, not seen in dislocation, can be obtained.

But, apart from the diagnosis in front of one's nose, so to speak, it is a good thing to analyse closely each of the symptoms, the collection of which constitutes the clinical syndrome of dislocation, and to study their importance.

The importance of the symptoms can be graduated from ordinary loss of function, some characteristics of which ought to be noted, up to the presence of a bony prominence, the offending body, slightly mobile in the carpal groove.

Loss of function, disturbance from nervous compression, shortening of the wrist, antero-posterior thickening, protrusion of bone : such are the progressive steps.

Loss of function is common : a simple sprain, a luxation of the scaphoid and of the semilunar may render the wrist immovable for some days. The fingers, however, are usually more movable and less swollen than in dislocation, and if the whole lower part of the forearm be very firmly held, at the same time asking the patient to let himself go, passive movements are easily obtained, when the injured person's mind is set at rest : movements which are never produced to such an extent in dislocation.

In subluxation of the scaphoid and of the semilunar with spring wrist, immobility is, so to speak, acute : it arises after a slight injury : the wrist has not lost its shape and the slightest traction on the hand puts everything in its place.

In old cases, loss of function may be due to several causes : fracture from cracking of the lower extremity of the radius ; fracture from impaction of the bone with expansion of the same, with scaphoidal and semilunar fragments : fracture of the scaphoid and of the semilunar : this sign has then in itself no very diagnostic value.

The nervous disturbances are not the prerogative of

dislocation : they are found in fractures of the scaphoid and in those of the radius, and even in violent contusions.

These disturbances are not always very marked : moreover, sometimes in dislocation in the first stage they do not exist at all.

They must always be looked for, even if the patient do not complain of them ; and it is not rare to find them after methodical examination.

In this way the difference of opinion on their constancy in dislocation is explained and can be expressed thus : they are not constant—often they are in the background and must be looked for—more often they are clamant.

But nervous disturbances exist in other cases than dislocation : Bouilly, Hamilton, Tillaux (in Clerc's thesis, Paris, 1884 ; Jourdan, Paris, 1895) have noted them in fracture of the radius : I have observed them five or six times without the slightest doubt.

Again, in fracture of the scaphoid, I have seen 9 cases with marked disturbances in the region supplied by the median nerve, and in two cases the radial nerve was affected.

To sum up ; deformity, diminution in height and antero-posterior thickening of the wrist, with the position of the hand and of the fingers make the diagnosis. Are these signs conclusive ? No, deformity is found with all its characteristics in fractures of the semilunar and in some isolated fractures of the scaphoid at the beginning, when swelling and œdema are present. These are rare cases, it is true, but must be noted.

As a final diagnostic, protrusion of the semilunar in the carpal groove, movable on flexing the wrist, is the best clinical sign, especially when accompanied by all the other symptoms.

But this sign is difficult to find. In Letenneur's fractures, in Smith's conchoid fracture, in tearing of the anterior lip of the radius, even also without displacement, we may have the sensation of a prominence.

Much more, in the fracture of Rhea Barton, protrusion of the upper fragment may be obvious. It is true, in many of these fractures of the radius, there is a displacement of

the bi-styloid line and the swelling on the back of the hand, but in fractures without displacement we almost infer from feeling the hard body it is the semilunar.

Again, we must not think protrusion of the semilunar is always very marked : the sensations on palpation are not always clear. But every diagnosis requires the same consideration : there are signs which point the way, others which confirm, and it is from the whole we form a conclusion.

DIAGNOSIS BY RADIOGRAPHY.—Everything is illuminated by radiography, but it is necessary also to make reservations and to know how to read the plates. When we see the grave lesions of dislocation, it would seem as if reading and interpretation of the plates would not be difficult. Alas ! in spite of everything published and written on the subject since 1898, I have seen in 1914 a confrère of Paris affected with this lesion and who had been radiographed, without the diagnosis having been made, and precious time had been lost before treatment was instituted. In order to read the plates, good ones are necessary : it is the infancy of the art—in front and in profile the radial border always against the plate : but, above all, the connections of the bones to each other must be known.

There is seen :

(1) On the plates, front view, the head of the os magnum is close to the border of the radius, and the cuneiform and the pisiform ascend to the ulna. The semilunar has generally lost its normal shape. It is usually transposed under the shadow of the cuneiform, and the superposition of the shadows and loss of the articular line between the cuneiform and the semilunar are to be noted. On the contrary, the space between the scaphoid and the semilunar is much increased, and change of shape and displacement are sometimes very slightly marked, but the profile corrects this impression.

The scaphoid has taken a special shape, when it is only luxated : when it is broken, its fragments appear distant from each other.

(2) On the plates, side view, the semilunar appears

separated from the os magnum, and it is sufficient to refer to the different images we have given in the anatomo-pathological chapter to see how easy is the interpretation and how extensive the lesions.

To sum up, reading the plates is not a difficult and a delicate matter : the displacements are so characteristic, they bring conviction and the diagnosis can be made without seeing the patient, simply from the images, and this is rare in diseases due to injuries.

PROGNOSIS.—This is easier to settle to-day than in the past years. What happens to dislocation if left to itself, or simply treated by massage and mechano-therapy ? What is the prognosis of dislocation of the carpus by the different methods suggested ?

Left to itself, dislocation of the carpus is a serious affection : anchylosis of the wrist, pain, serious loss of function in the fingers, trophic disturbances : that is the usual result.

Egenbrodt has, however, seen four cases end most favourably, and I have mentioned the observation of the case of an officer and of an old woman, who also recovered the function of the hand without reduction : ingenious necessity brought about perfect accommodation, for the officer's career was at stake, and the woman whose right arm had been amputated could employ a dislocated wrist.

In spite of other favourable cases the outlook is gloomy, not so much because of the anchylosis of the wrist, but from the pain the chronic arthritis produces and from the disturbances due to nervous compression. A violent injury destroying completely the use of the wrist and leaving the fingers free and active is better than limitation of movements which are constantly painful. Fracture of the scaphoid, when accompanied by dislocation, makes the prognosis worse.

The first stage of dislocation has a better prognosis than the second where the semilunar has lost its connections both with the radius and at the mid-carpal joint.

I have shown above the seriousness of complete enucle-ation of the semilunar. But if the lesion be serious if left

to itself, there are few lesions where treatment gives as good results.

As a whole, special considerations arise in a dislocation and the prognosis of dislocations applies here—reduction, the lesion is of little account ; unreduced, it is grave ; early reduction, the prognosis is excellent, later reduction the prognosis is less good, and nervous symptoms often persist which only disappear at the end of 6, 7 or 8 months.

The law of April 9th, 1898, regarding occupation accidents compels us to formulate the prognosis by figures.

Dislocation of the carpus shows like all dislocations, moreover, a well-marked alternative. Reduced or operated upon, the amount of permanent partial incapacity is reduced to 0 or to 2 or 3 per cent. Without operation and left to itself, it is equivalent often to the loss of the hand. The amount of the right hand varies, as we know, from 65 to 75 per cent.

The figure of permanent incapacity varies, then, from 0 to 75 per cent. In evaluing it, we ought to take into account many factors.

Unreduced dislocation with nervous disturbances, glossy skin, loss of function and pain represent the most serious case : dislocation of the first degree without painful symptoms, without anchylosis of the wrist, but without mobility of the fingers necessitating a change of profession, would be represented by 35 to 40 per cent.

Nearly complete recovery without reduction is not seen in workers who have suffered from an accident and have " cultivated " their lesion.

We shall see when speaking of treatment the result of reduction is usually excellent, and permanent partial incapacity falls to 2 or 3 per cent if the patient be willing to be careful.

Results differ in ablation of the semilunar : some are excellent, without incapacity : some are good, varying from 5 to 30 per cent : some are bad, reaching the figures of non-reduced dislocations.

Complete resection of the wrist, which we are compelled to perform in very old cases with bony trophic disturbances, has given in Vallas' hand good results for the most part :

but in spite of everything, it must be admitted a permanent partial incapacity of 30 to 40 per cent remains.

TREATMENT.—We must look at the recent and at the old cases. In recent cases, two methods exist at the present time : reduction, of which I am a convinced partisan, and operation, viz. resection of the semilunar ; this, according to M. Delbet, is the only treatment of choice. This last opinion, however, tends to be slightly weakened by the author himself, and M. Delbet is willing to admit (" Bulletin de la Société de Chirurgie," 1914) reduction in the first stage is possible.

I am certain, if dislocation of the carpus were treated as dislocation of the shoulder and its reduction attacked with set purpose, the best results at the beginning would be obtained.

There are, no doubt, some cases irreducible from the very first, but I have not come across them. We must not compare a case already old, reduced and left to itself, with one lately reduced, watched and carefully tended. Reduction, by its nature, is not a brilliant surgical procedure, and in hospitals, where the chief surgeon is occupied with serious operations, reduced luxations are ignored, as fractures in plaster—*de minimis non curat pretor.* Sometimes secondary recurrence occurs, or the reduction is incomplete and this has to be corrected and taken in hand : but from the surgical conscience, reduction should always be attempted in the belief it will succeed. and we should not be discouraged when nothing results. I have, both at the Hôtel Dieu and at the Hospital Desgenettes, reduced secondarily a dislocation which at the first attempt had failed, and have obtained a satisfactory result.

TECHNIQUE OF REDUCTION.—This is simple, but it requires sufficiently strong muscles and exact knowledge of the position of the bones. Anæsthesia is obligatory. An assistant fixes the forearm very firmly, resting it on a wooden table, the hand projecting and free. When the patient is unconscious, the whole wrist should be moved, flexed, extended and circumducted, especially in cases dating from 8 to 20 days. When the wrist is quite supple, the surgeon at the end of the limb clasps the patient's

hand in his two hands and draws it vigorously in the axis of the forearm, taking care to raise it and hyperextend it. The wrist must be lowered in this position and the displacement will be felt. The hand is then turned and slightly twisted to the ulnar side, so as to make the bed of the scaphoid and of the semilunar gape as much as possible. When the hand is judged to be sufficiently brought down, one hand leaves off traction, whilst the other maintains it, and by the end of the fingers endeavours to find on the anterior surface of the carpus the prominence of the semi-lunar : pressing on this prominence, from before backwards, it is pushed behind under the radius, whilst the hand is altered in position from hyperextension to flexion. The semilunar is well felt slipping under the fingers and returns to its correct position, and the arch of the wrist appears normal in height.

But we can proceed differently : after mobilisation, the hand can be drawn upon, always hyperextending it, and then the lower extremity of the forearm embraced by both hands, the thumbs joined on the root of the hand, on the prominence of the semilunar. We have thus more strength to replace the bone whilst the assistant flexes the hand. The purpose of hyperextension is to place the head of the os magnum in a good position to fit it into the semilunar. Once reduction is accomplished, it is possible to seize the semilunar between the thumb on its palmar and the index on its dorsal surface, and to move it, at the same time noticing if its nornal connections with the glenoid and os magnum have returned.

There is no trouble with the scaphoid, which usually returns into its place by itself. When it is broken, a blow of the thumb in the anatomical snuff-box suffices to push it forward : the hand should be forcibly inclined to the ulnar side, to compel it to return into place, and its curve moulded to the head of the os magnum.

This reduction can be carried out up to the 25th day, later than that the pressure employed is dangerous, for the nerves are already compressed and in a bad condition and resection is preferable. I have reduced cases dating back two months, but cannot recommend it.

Some cases are irreducible from the beginning : I am willing to admit this : although I have not seen them. Why are they irreducible ? For different reasons : some can be conjectured in advance, others give no indication. The first are those in which the semilunar, deprived of all attachments, is thrown on to the anterior surface of the forearm, or under the skin. It is useless in these cases to try and replace the bone, which is from the beginning bound to fail.

The second may be due to the interposition or to the invagination of the anterior ligament : it is only after fruitless attempts that irreducibility can be said to be impossible. The drawings of a case, which I reduced with my friend Durand, show the radiographical appearances cannot be taken as a criterion.

Delay in reduction plays also a part. The difficulties increase with time. I do not think more than 25 days should have elapsed. Energy and perseverance succeed in many bad cases.

When reduction has been thought to have been attained, the hand is fixed in the flexed position with a small plaster splint for 5 or 6 days, which is taken off afterwards and the hand gently moved.

Reduction should be verified by the X-rays.

Patients usually find insensibility has improved after the first few days without, however, anæsthesia at first disappearing, for it is not rare to find the disturbances existing for 2 or 3 months. If the pains persist without change after reduction, a new radiogram should be taken to make sure the dislocation has not recurred. It may have been a mistake or a bad reduction and it is necessary to begin again immediately.

There is a special form of immediate recurrence in which the anterior ligament, separated from the border of the radius, allows the semilunar to slip in front of the os magnum, the anterior horn below. We draw on the bone and reduce it, but dislocation returns when we let go the hand. Reduction is only maintained by continuous traction and I have cured this year a man who showed this form, by making him carry a plate of lead fixed to the back of the

hand like an ancient cestus, which he only let go in order to carry a dumb-bell of 200 grammes. At the end of a month all the movements of the hand returned.[1]

Treatment by operation. There are many methods :

(1) Reduction by operation :
(2) Reduction of the semilunar with its different methods, also resection of the wrist.

Reduction by operation was performed by Vallas in 1897, but presents no real advantage.

Resection of the semilunar, if it be the operation of choice in an old case, deserves discussion in recent cases.

We must certainly reject it at first. The partisans of this operation in the treatment of dislocation directly it has occurred, take their support on theory and on the excellent results obtained. Theoretically M. Delbet has maintained reduction was impossible and operation ought to be performed at once. Facts answer this allegation better than argument. As regards the excellent results of ablation of the semilunar, it is necessary to make reservations. Every surgical operation has its risks.

I have seen in practice, where although asepsis was sufficient for abdominal operations, infections of the wrist with suppuration and subsequent anchylosis. I have also seen in hospitals, skilled surgeons have bad results, an adherent cicatrix, or an open sheath, and in spite of everything published, these facts should be noted and are too willingly passed in silence. The cases to which I have alluded are unpublished and I do not consider I have any right to make them known, but they justify my opinion.

With these reservations, I admit operative measures are justified :

(1) When, after serious attempts, reduction has not been obtained, whatever be the cause of the irreducibility :

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[1] I have seen this year 7 dislocations : 4 recent, 3 with immediate reduction and with good results, and one operated upon by a hospital surgeon with deplorable result : 3 old cases, one very old one in a student cured with partial anchylosis, one dating back a month, an occupation accident, which the patient did not desire to be operated upon, although it was in the first stage, and one, lastly, dating from 45 days, operated upon with a bad result. If I give these small figures, it is because they appear to me to answer the present truth.

(2) When there has been a month's delay : I have reduced at the end of two months, but have not been satisfied with the result :

(3) When there exist complications in the wound and infection, when it is necessary to incise and open widely. Remove the semilunar and all the remains : cleanliness and disinfection are urgently needed.

Resection of the wrist may be necessary in cases of purulent arthritis : if it be not sufficient, amputation may be the last resource. This eventuality may appear exaggerated in our day : it is not so, and I will report further on the only observation of radio-carpal dislocation I have seen, which ended in death. The articular wounds of the wrist, the irregular synovial membranes and the adjacent tendinous sheaths render infections particularly to be feared.

OLD CASES. — In old cases, the following have been recommended :

(1) No treatment, or mechanical treatment and massage.
(2) Reduction by operation.
(3) Removal of the dislocated semilunar, with or without fragments of the scaphoid.
(4) Complete resection of the carpus.

Abstention from treatment is only advisable in special cases, where there are no pains from nerve compression, or where the dislocation is in the first stage, and seen at the end of 3 or 4 months, with some movement already existent. The wrist itself being immovable, if the fingers have complete movement, we should hesitate to operate, but, I repeat, it is exceptional.

Late reduction by operation is a bad operation. If, strictly speaking, this procedure be permissible in recent irreducible dislocation, when neither new formation of cicatricial tissue exists, nor adhesions, nor deformity of the bone, in old cases, it presents difficulties.

Removal of the semilunar with or without removal of fragments of the scaphoid is the operation of choice,

It is indicated after one month. The procedure varies. The anterior or the posterior route may be employed. The latter is much more difficult and more mutilating. The anterior route is to be preferred, besides being so rational that even before radiography had shown the frequency of dislocation of the carpus, surgeons had been led to follow it in order to remove the semilunar which protruded on the anterior surface of the forearm and sometimes under the skin.

Malgaigne in 1855, Chisholm in 1870, Cameron in 1884 and Gamgee in 1895, finding compression of the tendons and of the nerves from a tumour, directly attacked the obstacle without making a precise diagnosis. Berger, Dubast and Potel did the same in very marked cases, and I do not understand why Jaboulay claimed priority for this intervention.

The operation is very simple in itself, but it requires extremely rigorous asepsis : it ought to aim at making the minimum destruction and manipulations : it ought to avoid, as far as possible, wounding the tendinous sheaths and subsequent drainage.

Operation may be performed under general anæsthesia, or with a local anæsthetic, by Reclus' method. Some German surgeons have employed it. Esmarck's bandage which produces ischæmia is advantageous : it avoids the use of troublesome forceps, which encumber a limited operative field.

A longitudinal horseshoe incision 8 centimetres in length, over the middle fold of flexure of the wrist between the tendons of the palmaris longus and the palmaris brevis, i.e. a little outside the axis of the forearm, should include the whole of the skin and the cellular tissue. The superficial aponeurosis and the anterior ligament of the carpus being cut, the bistoury should be laid aside, and the grooved director guided towards the prominence of the semilunar, avoiding the sheaths of the tendons. The palmaris brevis, the median nerve and the flexor tendons should be pulled away from the ulnar side. The hand is to be flexed, and the whole mass retracted by a Farabœuf's retractor. The knife should then again be taken, and all the fibrous

parts remaining on the luxated bone cut. The latter should be caught with a strong pair of Museux's forceps, consisting of three teeth (it is the best bone foreceps), and freed by the raspatory and by scissors. The hand should be drawn upon and all the osseous and cartilaginous débris and the separated remains of the scaphoid found in the joint removed. The wrist is to be rendered mobile and the anchyloses which may exist broken down. The anterior ligament should be sutured with catgut.[1] All bleeding must be carefully stopped and the skin exactly sutured. The wound ought to be cicatrised in 10 days.

If there be compression of the ulna nerve, the line of incision is to be carried internally, between the flexor bundle and the anterior ulna nerve. This incision is in the majority of cases preferable to the former, for the plates show nearly always the semilunar is enucleated anteriorly and internally, finding an easier path because of the triangular radio-ulnar ligament. It is the route indicated when the lesions of the scaphoid are not too marked, and is to be chosen after studying the plates.

After the first dressing, i.e. about the sixth to the eighth day, the wrist should be moved actively and passively. Massage ought not to be employed.

Adherent cicatrices should be avoided : they keep up the nervous disturbances and render the wrist immobile by their prolongation into the tendons and into their sheaths.

Adherent cicatrices are due to a slight infection and compromise the result. Loss of tissue should be minimal and asepsis should be complete. Success is dependent upon them.

The three patients on whom I have operated left the nursing home at the end of 15 days with a mobile wrist, and although some anæsthesia persisted, at least all the pains had disappeared. The function of the hand had returned at the end of three weeks in one case, and in three months in the other two.

Tavernier in his thesis has made statistics of 44 cases. He eliminated at first 2 cases (Albertin, Hodges), followed

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[1] If the semilunar be situated high up, division of this ligament is unnecessary.

by fatal infection, and then 12 others which were only under observation for 10 days. Of the 30 cases remaining, he noted: 3 bad results (Richon, Hildebrandt, Höfliger): 10 excellent results (Cameron, Chisholm, Gamgee, Haughton and Holt, Hildebrandt 2 cases, von Lesser, Lilienfeld 2 cases, Wendt), without permanent partial incapacity and 17 cases with good results (the strength of the hand was diminished, the movements were limited, but there were no pains, the patients could work, but some had to change their profession). The results were good only at the end of six months and sometimes longer. The disturbances due to compression of the nerves were a long time in disappearing (P. Delbet, Jaboulay, Ecot).

Berger, Höfliger, Malgaigne and Potel have had, however, good results at the end of one or two months.

Tavernier has endeavoured to find out whether fracture of the scaphoid was a serious factor. He found:

Of 3 bad results: 3 fractures of the scaphoid.

Of 17 quite good results: 9 fractures of the scaphoid.

Of 10 very good results: 1 case of fracture of the scaphoid, that of Haughton and Holt, who had removed at the same time the scaphoid, the semilunar and cuneiform, but the luxation was mid-carpal rather than a dislocation.

We must allow with even good results, a permanent partial incapacity must be faced, which may reach 25 per cent to 30 per cent, and involves a change of profession.

It is as regards occupational accidents the mentality of the patients has to be considered, and this is perhaps the greatest and most serious factor. I have seen a young locksmith, 21 years of age, with dislocation of the carpus, who preferred to have a functionless right hand rather than to submit to operation. I had to grant him 55 per cent (the pains were slight). I have seen, on the contrary, a peasant, owing to the exigencies of harvest-time, return to his laborious work three weeks after operation.

The estimation of the amount of incapacity is to be appraised rather from the functional state than from the anatomical alterations, and great consideration should be given to the profession of the patient.

Complete resection of the carpus. When in 1897, enlightened by an operative reduction performed by my friend Vallas, our attention was drawn to anchylosis of the wrist following an injury and to dislocation, for some time we only came across old cases. Vallas made partial resections, which gave bad results, as Olliver noted. It was then he was led to practise in old cases complete resections which gave excellent results (it was only in 1898 we had under our care the recent case of a confrère). Complete resection of the wrist has its well-marked indications. (I hope in the near future, when diagnosis will be made early and early intervention practised, this operation will not be carried out any more.) When, after a non-reduced dislocation, nervous trophic symptoms are observed, degeneration of the carpal bones transforming them into deformed fatty masses, without consistency, when radiography shows transparent de-mineralised bones with a mottled appearance, the contours irregular and with hardly any double line, the fingers clubbed, swollen and immobile with hyperidrosis, the nails friable and vascular troubles of the skin, then complete resection of the wrist is indicated.

It is impossible to fix a time, for the phenomena are more or less slow in appearing.

Removal of the scaphoid and of the semilunar only, or even of the first row, does not suffice to restore certain movements of the hand. It ought to be condemned, because pains may persist and traumatic arthritis may continue, kept up by a small fragment of bone which has been preserved. The observations of Vallas are a clear argument in favour of complete resection in old cases. It is the last resource to give good results, but this operation ought to lose its indications more and more, as by degrees the diagnosis is made earlier.

To sum up, the treatment of dislocation of the carpus is guided by the following rules :

I. During the first few days, reduce the displaced semi-lunar.

II. After one month, remove the semilunar with the fragment of the scaphoid.

III. In old cases, with pain and trophic disturbances, resect the wrist entirely.

We see, then, the whole effect of treatment is to be directed against the dislocation of the semilunar, and its lesions are those occupying the first place.

II.—Mid-carpal Luxation

The distinction between dislocation and mid-carpal luxation is certainly difficult. The only difference is in the participation of the cuneiform in the lesion : it may be found broken and dislocated on to the palmar or on to the dorsal surface, or simply luxated in front with the semilunar : it is, properly speaking, this *last form which answers to a true mid-carpal luxation*. Thus the first row, the cuneiform, the semilunar and the upper half of the scaphoid are tilted on to the palmar surface, and the whole of the second row with the base of the scaphoid is luxated posteriorly. *This is palmar luxation of the first row.* There exists another form of mid-carpal luxation, which we will mention shortly, the only two observations we know, viz. when the second row with the metacarpus is luxated anteriorly, whilst the bones of the forearm and the first row remain behind. *This is palmar luxation of the second row.*

But in the form where the cuneiform is broken and sub-luxated posteriorly, we may argue, whether we are not dealing with a third degree of dislocation, the three steps of which would be therefore :

(1) The semilunar has preserved its connections with the glenoid cavity of the radius, and the scaphoid is broken or tilted.

(2) The semilunar has lost its connections both radio- and mid-carpal, and the scaphoid is broken and tilted.

(3) The force not being exhausted, the cuneiform comes in contact with the ulna from tearing of the triangular ligament and is flattened and broken on the dorsal surface of the unciform bone. Moreover, in falls on the hypothenar eminence this lesion of the cuneiform is to be found isolated : this hypothesis is then perfectly plausible.

Fig. 62. Dislocation of the Carpus with Laceration of the Cuneiform.

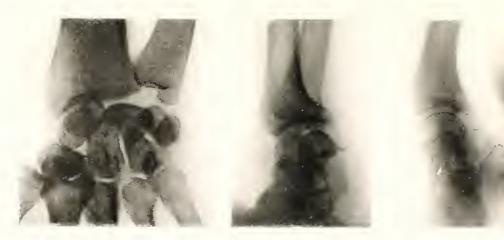FIG. 62 (a).—DISLOCATION OF   (b) THE SAME, SIDEVIEW.   (c) THE SAME IN PLASTER
THE CARPUS.   AFTER REDUCTION.

FIG. 63.—MID-CARPAL LUXATION, WITH FRACTURE OF
THE RADIUS

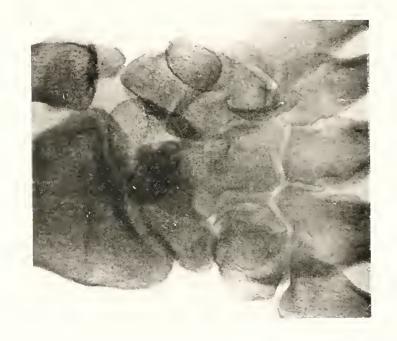FIG. 63a.— MID-CARPAL LUXATION, WITH FRACTURE OF
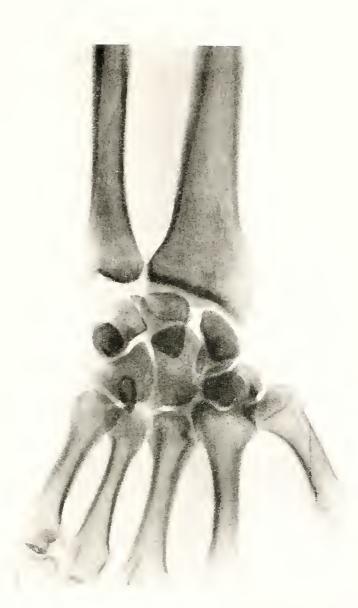THE RADIUS.

FIG. 64.—MID-CARPAL LUXATION.

FIG. 65.— LACERATION OF THE CUNEIFORM WITH DISLOCATION OF
THE CARPUS

FIG. 66.— LACERATION OF THE CUNEIFORM WITH DISLOCATION OF THE CARPUS.

The cases of dislocation of the third degree or of mid-carpal dislocation of the first row consist of the following :

Four autopsies, Maisonneuve, Després, Claudot, Richemond.

Labady, in 1897, published a typical observation, and M. Chaput, in 1914, reported another to the Surgical Society. I have published 2 cases, Goullioud and Arcelin, and Mouchet and Vennin have reported two observations of palmar mid-carpal luxation of the second row.

In the first, a man-servant, who was washing the windows, fell from his ladder and caught his fingers on the edge of the window ; so violent was the fall that the skin and palmar aponeurosis were cut and the os magnum and the second row where luxated anteriorly. In the second case, which I saw at Val-de-Grâce, an officer had fallen from a balloon and the dislocation had not been reduced : nothing was known of the way he fell.

There are then three forms of mid-carpal dislocation : The first, which is only the third degree of dislocation of the carpus, when the cuneiform fractured or not, luxates posteriorly.

The second, when the whole of the first row luxates in front and the cuneiform is or is not broken, the scaphoid leaving its lower fragment fixed to the second row : this is *palmar mid-carpal luxation of the first row.*

The third, very rare, when the whole of the second row with the metacarpal is fixed in front : this is *palmar or mid-carpal luxation of the second row.*

The pathogeny is very obscure. In certain cases, we must admit the chain of facts which have led us to consider this luxation as a third degree of dislocation, when the cuneiform is luxated posteriorly and broken or not. In other cases, the patient's hand is maintained in hyper-extension : whilst the first row fixed to the radius is drawn anteriorly, the second, the metacarpus and not the base of the hand, coming in contact with the ground may be pushed backwards, and this special mechanism causes the luxation.

The same explanation, moreover, applies when the second row and the metacarpus are luxated on the palmar

I

surface, whilst the first row and the bones of the forearm are displaced to the dorsal surface.

SYMPTOMS AND TREATMENT.—We will study the three forms in turn.

I.—Third degree of dislocation. It is rarer than true dislocation : it has the same clinical picture, with symptoms connected with the internal column predominating. Fracture of the cuneiform in addition does not aggravate the prognosis. This fracture is cured perfectly, without leaving a trace.

The treatment is the same as for dislocation. Reduction is, however, more difficult.

Haughton and Holt have performed complete resection of the first row with an excellent result.

II.—Palmar luxation of the first row. It is the luxation of the cuneiform anteriorly which produces extremely marked nervous symptoms. The wrist is much more deformed than in simple dislocation. Excluding details and the pathological anatomy, which is a little more complicated, the radiograms well show what we have said on dislocation applies to this lesion. The treatment is the same with, however, greater difficulty in reduction.

III.—Palmar luxation of the second row. The deformity is absolutely different from that of dislocation. The wrist takes the form of a **Z**, i.e. the prominence of the bones of the forearm and of the first row form a kind of protrusion on the back and there exists a deep depression, outside of which the metacarpus, more or less flexed, is continuous with the hand.

There are no symptoms of nervous compression. Goullioud reduces this dislocation very well.

In the case of the officer, reduction was not performed, but the subsequent disturbances were minimal : excluding the deformity and limitation of the movements, the functional power returned, save 20 per cent permanent incapacity.

The interesting point of the history is the differential diagnosis with radio-carpal luxation : we will return to

it after studying the latter, in order to attempt a differ-
ential clinical diagnosis of the different deformities of the
wrist, especially Madelung's disease, chronic tabetic, or
tubercular arthritis and deformities due to unrecognised
anterior marginal fractures (Letenneur).

To sum up, mid-carpal dislocations are very rare and are
differentiated from dislocation of the carpus by the
pathological anatomy alone : this is the indisputable point
in their history. Their pathogeny is obscure, without any
utility at the present time, and we have preferred not to
develop theories more or less ingenious. Their treatment
is the same as that of dislocation.

FRACTURES OF THE OTHER BONES OF THE CARPUS

They are very rare and of importance according to their rarity : it is difficult to describe their history. They are chance findings. In order of frequency, we must mention :

(1) Fractures of the cuneiform.
(2) Fractures of the os magnum.
(3) Fractures of the trapezium.
(4) Fractures of the unciform.
(5) Fractures of the pisiform.

Their claim to interest consists in the recognition of persistent pains and loss of function, and in occupation injuries their presence allows of our judging fairly the claims of the injured.

(1) Fractures of the cuneiform are rare. I have observed four marked isolated cases, without mentioning small lacerations which are found in dislocations of the carpus, as a result of diastasis of the cuneiform and of the semilunar.

Bérard, Maetzke, Baum, Plagemann and Deneck have noted cases. I have seen them associated with fracture of the styloid process, of the head and also of the lower quarter of the ulna (Castruccio, Witteck, Oberst, Deneck confirm this occurrence).

In dislocation and especially in mid-carpal luxation, it is frequent to find comminuted fractures of the cuneiform.

They can be due to a direct cause (Bérard). In this case, the hand of the patient struck directly the edge of a pavement. In Deneck's observation, a sack fell on the hand.

Most often, the cause is indirect : a fall on the hypothenar eminence, the hand being extended and turned to the ulnar side.

Sometimes the cuneiform is subluxated dorsally and also fractured. In cases associated with fracture of the ulna, at the same time as the hand rested on the hypothenar eminence, it was over-inclined to the ulnar side and twisted. In one of my observations, a labourer,

standing on a train of Decauville wagons, was coming down a slope : he wished to stop by placing his hand in front on a wall which lined the way : but, instead of resting the hand *in toto*, he only supported himself on the hypo-thenar eminence, and I found a fracture of the cuneiform bone and of the lower quarter of the ulna.

In these cases it is not rare to find nervous symptoms in the area supplied by the ulna nerve.

Fracture of the cuneiform is very troublesome if it be associated with dislocation or mid-carpal luxation : it can prevent reduction (Chaput). In two cases I have treated, reduction was accomplished with perhaps a little more difficulty, but I obtained it all the same.

In isolated cases the prognosis is usually good. A slight weakness exists in the wrist, but usually the move-ments are not hindered.

The only point to note is the difficulty of reading the radiogram. In one case which I assessed in January, 1914, and awarded 2 per cent partial permanent incapacity, radiographers and surgeons had not made the diagnosis.

In association with fracture of the ulna the prognosis is much more serious, but it depends less on the fracture of the cuneiform than on that of the ulna and of the dis-placement of its head, on the diastasis of the radius and of the ulna and on compression of the ulna nerve.

In association with mid-carpal luxation, I do not hold to Chaput's opinion on the irreducibility of this fracture.

(2) Fracture of the os magnum. Robert in 1845, Bardenheuer, Moty, Guermonprez have reported observa-tions.

Brigel (" Congrès Allemand de Chirurgie," 1906), Harrigan (" Annals of Surgery," 1908), Peterson (" Medical Record," 1909) and Lebouc have mentioned cases.

I have had the opportunity of seeing 4 cases and I have noted them in Cousin's thesis (1897). Sometimes the neck is decapitated, sometimes the base of the bone is torn from its joint with the third metacarpal bone. Decapitation of the neck can be produced experimentally. Gallois and I have succeeded in this experiment, which shows the rôle of the posterior lip of the radius which is often broken.

Fractures of the base are usually produced with the hand in forced flexion. In one of my observations, a cavalry officer had been thrown from his horse in this position.

Harrigan has observed the same position of the hand : Guermonprez has found a longitudinal fracture breaking the bone in its axis.

Fracture of the os magnum is often associated with other fractures of the carpus. The signs are not marked ; swelling in the region of the bone and pain, rarely crepitus.
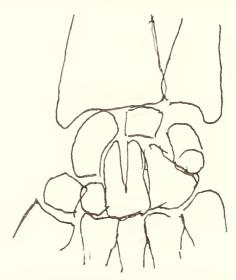

FIG. 67.—VERTICAL FRACTURE OF THE
OS MAGNUM (Guermonprez's case).

It is radiography which makes the diagnosis certain.

The prognosis varies. Petersen's patient was cured : but I have always, like Moty and Harrigan, seen limitation of the movements, loss of power and sometimes persistent pains.

Treatment consists in early gentle and progressive mobilisation, *without massage*, very warm baths and hot air.

(3) Fracture of the unciform bone. Leriche, Van Albers, Schönberg, Chevrier, Ebermayer, Grashey, Mouchet and I have observed cases.

The fracture often occurs in the unciform process (Chevrier, Leriche, Eigenbrodt, Ebermeyer). Leriche has well pointed out the method of bringing it to light.

The hand placed behind the back of the patient, in hyper-extension, embracing the edge of a table, the tube trans-mitting deep rays.

Sometimes the bone is cracked.

Sometimes a transverse oblique line divides the base of the triangle of the unciform bone, separating the apex.

(4) Fracture of the pisiform. Alsberg (" Zeit. f. Orthop. Chir.," 1908) and Deane (" Annals of Surgery," 1911) have noted fractures of the pisiform.
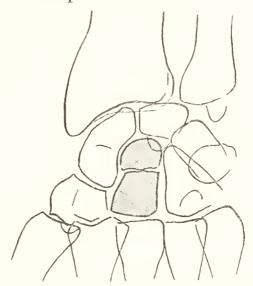

Fig. 68.—Decapitation of the Neck of the Os Magnum.

In Guibout's case, the pisiform was broken at the same time as the cuneiform, the scaphoid and the os magnum.

(5) Fracture of the trapezium. Very rare. I have seen 4 cases associated with fracture of the base of the scaphoid. I have seen it associated with fracture of the scaphoid and of the radius, and of the scaphoid, of the semilunar and of the radius.

Ricard and Dumoulin, Grashey and Courtin have seen cases. The prominence of the fractured trapezium may simulate fracture of the base of the first metacarpal. These fractures produce pain on moving the thumb and loss of power on squeezing.

Early, progressive and gentle movement, active and passive, four or five days after the accident restore the movements.

RADIO-CARPAL LUXATION

AFTER having occupied the whole stage up the nineteenth century, radio-carpal luxations have lost all importance. Pouteau, Colles and Dupuytren especially destroyed the Hippocratic teaching and fractures of the radius took their place. This was unfair and wrong. Abadie, in his thesis, after a careful sorting of the records, could collect 71 cases.

But radiography has allowed us to extract also from these cases a certain number of facts. Mid-carpal dislocation and dislocation of the carpus, best known and best determined, justify some observations. Lastly, pathological dislocations, much more frequent than Abadie thought, and congenital deformities, particularly clubbed hands, Madelung's disease, some deformities following contraction of tendons, form a whole that was formerly mixed up under the same name of radio-carpal luxation and which to-day can be distinctly distinguished and separated.

Personally, although it is 18 years since my attention was directed to this question, I have only seen one case of true radio-carpal luxation, without fracture of any kind. It concerned a fat man, 50 years of age, who was thrown into the Saône by his runaway horse and remained suspended by the reins. A postero-external luxation resulted and the whole carpal condyle protruded through a wound occupying the anatomical snuff-box and extending into the forearm. Dr. Bonnet of Neuville immediately reduced it. The patient was brought to Lyons and placed under observation, but in spite of all antiseptic treatment he became infected (he was also a diabetic): notwithstanding resection and as complete drainage as possible, he died. As a result it was possible to prove he had no fracture, but rupture of the external lateral ligament.

But if radio-carpal luxations have lost their importance because of their extreme rarity, they raise one of the most interesting problems in the diagnosis of deformities, congenital or acquired, traumatic or pathological, of the wrist, and for this reason deserve our attention. The old

Fig. 69.—Madelung's Disease.

confusion with fractures of the lower extremity of the radius had already well shown one side of the problem. The different affections we have just enumerated allow us to look at other facts. It would seem, a priori, with radiography the problem would be easy to solve. This is true for recent cases, but is not so for old ones.

Here are some facts demonstrating this statement.

On 28th May, 1900, Manson showed at the Medico-Chirurgical Society of Paris a case of anterior dislocation of the carpus. The plates showed quite clearly the case was one of Pouteau's fracture.

At the Surgical Society of Lyons, Messrs. Gouilloud and Arcelin showed a young woman they considered was suffering from a palmar radio-carpal dislocation, analogous to their well-known case of 1908. Japiot and I showed the case was one of nervous arthropathy, and the authors were compelled to acknowledge the fact.

Some months since in the practice of Prof. Quénu, there entered a woman with an enormous deformity of the wrist simulating an anterior radio-carpal luxation with spontaneous division of the extensor minimi digiti. Radiography showed a small anterior fracture absolutely identical with the drawing reproduced everywhere of No. 737 in Dupuytren's Museum and catalogued anterior dislocation of the carpus, and a Letenneur's fracture was diagnosed. But the case was one of arthritis deformans, where injury played only a trifling part and did not hinder the patient from working. In addition, this woman showed arthritis deformans in the fingers and in the metacarpus of the left hand, in the knees and in the tibio-tarsal joints, with exostoses on the os calcis.

These examples show how cautious we should be. The famous case 737 is classed by some as a fracture of the radius, by others as an anterior dislocation, and the case I have just mentioned was manifestly one of chronic arthritis deformans. If then radio-carpal luxation have lost much of its old importance, if in recent cases the violence of the injury and the absence of bony lesions, as shown by radiography, allow of a diagnosis, we ought at least to be very cautious in our consideration of old cases,

even when we have pieces from an autopsy, and this is why
the piece 737, the cases of Curtillet and of Gaudin, etc.,
ought to be admitted only with the greatest reserve.
With these restrictions it is easy to sum up the history of
radio-carpal luxations.

Formerly, four classes were distinguished : (1) Anterior :
(2) Posterior : (3) External : (4) Internal, according to the
four cardinal points.

To-day, only the anterior and posterior forms are
described. Posterior luxations are more frequent than
anterior. They are often complicated by a wound.
Rupture of the lateral ligaments is constant.

Experimentally, Abadie has been able to produce them,
taking care to fix the two rows of the carpus so as not
to disperse the force of torsion of the hand into forced
pronation or supination.

It is met with more often in the male than in the female,
but in adults only.

In authentic observations there have been noticed
falls from a height, and either a blow or pressure on the
bent elbow, the hand being hyperextended. To sum
up, traction or torsion of the wrist, a fall on the back or
on the palm of the hand, with dragging of the latter
into pronation or supination. The signs naturally vary
in anterior or posterior luxation. Deformity is con-
siderable. In recent posterior luxation, an enormous
swelling forms on the back of the hand, but the bi-styloid
line has preserved its obliquity and the carpal condyle,
which stands out from the dorsal surface of the forearm,
shows a rounded form, without marked prominence. In
anterior luxation, the ends of the two bones of the forearm
with their prominent styloid processes are clearly seen and
felt, whilst the anterior prominence of the carpus raises like
a ball of string the flexor tendons. Loss of function is
considerable, and compression pains very acute in the
anterior form, but are absent in the posterior variety.
Compound dislocations are very serious owing to early
infection. The diagnosis of recent luxations has to be made
from fractures of the radius. Wertheimer, in 1839, drew
up the following table embodying the differential signs.

Fracture of the Radius.	Dislocation of the Wrist.
1. Depression on the internal border of the forearm near the joint.	1. No depression on the internal border of the forearm.
2. Abduction of the hand.	2. Total displacement of the hand on the external side of the forearm.
3. Swelling of the anterior and lower part of the forearm.	3. No swelling of the forearm.
4. Anterior and posterior protrusions produced by the fragments hardly noticeable.	4. Protrusion 7 or 8 lines in extent, one posteriorly by the carpus, the other anteriorly by the bones of the forearm.
5. The carpo-metacarpal bony level greater than that of the other limb.	5. The carpo-metacarpal bony level equal in both limbs.
6. Radius shorter on one side.	6. The radius the same length in both limbs.
7. The styloid process has preserved its connections with the carpus.	7. The styloid process of the radius displaced internally to the carpus and to the scaphoid.
8. The styloid process of the ulna prominent posteriorly.	8. The styloid process of the ulna prominent anteriorly and externally.
9. The styloid process of the ulna descends to the same level as that of the radius.	9. The relationship between the two styloid processes is preserved.
10. The hand is usually extended posteriorly but not constantly.	10. The hand is in the flexed position.

Such a table is rather a summary.

Three fractures of the radius resemble luxation : the classic fracture of Pouteau, the anterior marginal fractures of Letenneur and the posterior marginal fractures of Rhea Barton. These latter fractures are especially difficult to diagnose, because Pouteau's fracture with the swelling on the back (Velpeau) is situated too much above the carpus for it not to be localised immediately, on examination of the bones of the forearm, at the level of the fracture.

It is not the same for the marginal fractures, in which

the fragment may be very small and the protrusion of the carpus very marked. The luxation may be very great in posterior dislocation, but fracture is usually more painful than luxation and radiography will easily settle the difference.

In the anterior form, the deserted bones of the forearm protrude : the carpus forms a deep slope anteriorly, much more marked than is seen in posterior marginal fractures.

The rare and most difficult diagnosis to make is that of palmar mid-carpal luxation. In Mouchet's and Vennin's case the wrist showed a well-marked deep depression, analogous to that of anterior radio-carpal luxation, but the radius and the ulna did not form the two protrusions marked in luxation. The differential diagnosis from congenital and pathological deformities does not arise in recent cases.

In old cases, etiology plays the greatest part. In pathological cases, if an injury be present, it is easy to find it has not been considerable, whereas a true mid-carpal luxation requires enormous force for its production. On the other hand, there are other signs which we will analyse in the study of old fractures of the extremity of the radius.

Naturally, the prognosis of radio-carpal dislocations is grave, not so much from the violence of the injury which has caused them as from the complications from the wound, from infection, or from the nervous disturbances which accompany them.

Treatment is obviously reduction.

This is usually easy, judging from the cases I have seen. I will not lay stress on this point, which has lost nearly all its importance on account of the rarity of the lesion.

FRACTURES OF THE LOWER EXTREMITY OF THE RADIUS

IF, as we have shown, the radio-carpal space clearly separates the carpal region from the forearm, if the bi-styloid line mark the boundary, it is certain from the pathological physiology the two parts recoil on each other, and in considering the nosology the lower extremity of the forearm cannot be separated from the carpus.

We have already seen a certain number of traumatic associations which show the close relationship binding the two segments : we will examine in detail the pre-dominant lesions of the lower extremity of the radius. It may seem astonishing, at first sight, the action of the carpus on traumatic lesions of the lower extremity of the forearm had not drawn the attention of clinicians.

The principal reason depends upon the extreme fre-quency of fractures of the lower extremity of the radius, which naturally brought in its train a generalisation of views. The theoretical ideas and experimentation con-firmed too well the clinical facts and absorbed the whole attention.

Malgaigne estimated fractures of the lower extremity of the radius represented one-tenth and Dupuytren and Goyrand one-third of all fractures.

Plagemann, out of 237 fractures of the forearm, found 73 cases of isolated fractures of the radius and 38 of its lower extremity. I believe these figures are not correct and do not correspond with what really occurs. If hospital cases be examined, all of which come from one part of the town, it is certain fracture of the lower extremity of the radius represents nearly two-thirds of the cases, whereas in private practice Plagemann's figures are applicable, because many of them are not hospital ones.

But the fracture of the type Pouteau-Colles was soon divided. Goyrand showed an inverse type of deformity : Dupuytren described stellate fracture from impaction and splintering of the epiphysis : Rhea Barton posterior marginal and Letenneur anterior marginal fracture : Hutchinson, fracture of the styloid processes, and Bennett,

fracture of the sigmoid cavity. The form of the line of
the fracture was especially studied by the old surgeons in
order to seek for pathogenic arguments, and so the obliquity
anteriorly and posteriorly became the source of too in-
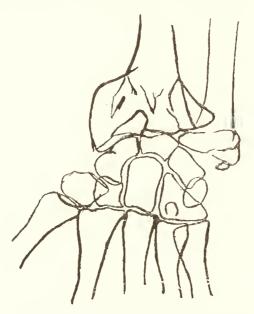genius theories which Malgaigne reduced to reason.

FIG. 70.—FRACTURE BY SPLINTERING.

Dudouyt, in his thesis written under Rieffel's guidance
and based on the pieces in Dupuytren's museum and from
Poirier's collection, described six anatomo-pathological
varieties and P. Delbet mentions nine :

(1) Tranverse fracture : the classical one of Pouteau-
    Colles.
(2) Oblique in the antero-posterior direction.
(3) Oblique in the tranverse direction.
(4) Posterior marginal of Rhea Barton.
(5) Anterior marginal of Letonneur.
(6) Isolated fracture of the styloid process of the radius :
    Hutchinson.
(7) Fracture of the radius associated with fracture of the
    styloid process of the ulna.
(8) Vertical fracture of the lower fissure of the extremity
    of the radius.
(9) Fracture of the small sigmoid cavity : Bennett.

The stellate fissural fracture of Dupuytren, true splintering, must be added to these nine types.

But all these varieties are far from including the whole complexity of the subject, as revealed by radiography.

In children, for example, separation close to the epiphysis is recognised, and radiography has shown the great frequency of a fracture of the metaphysis situated above the cartilage, a bending with incomplete subperiosteal fracture, and a variety, the so-called infraction (de Quervain). But
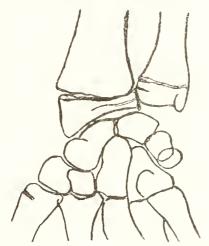

FIG. 71 —SEPARATION CLOSE TO THE EPIPHYSIS.

this is not all. Gallois and I have shown the rôle of the carpal condyle in fracture of the lower extremity of the radius, and I have brought into prominence a scaphoidal and a semilunar fragment and a series of cuneiform fractures going from the base of the styloid process up to an oblique line, ending at the lower radio-ulnar joint, a fracture in Y, an impacted fracture with expansion of the fragment and a spur-like fracture.

In a word, there exists at the present time such a diversity that we are compelled to notice the principal characters of these fractures in order not to plunge into anatomical details of no great clinical value.

Fractures of the lower extremity of the radius can be divided into :

(1) Extra- and intra-articular fractures.

(2) Fragmentary or whole fractures, complete or incomplete, with or without displacement.

Extra-articular fractures are easy to classify :
(1) Pouteau's type.
(2) Separation close to the epiphysis.
(3) Infraction or Pouteau high up.
(4) Antero-posterior or tranverse oblique.

Complete intra-articular fractures are :
(1) Splintering.
(2) Dupuytren's stellate fractures.
(3) Fractures in Y.
(4) Fissures.
(5) Impacted fractures with expansion.

The partial intra-articular fractures are :
(1) Fractures of the styloid processes (Hutchinson) :
(2) Bennett's fracture.
(3) Cuneiform fractures with a more or less large wedge.
(4) Impacted fractures with a spur of bone.
(5) Anterior and posterior marginal of many degrees
    according to the thickness of the affected border.

The classification above gives the best representation of this collection of fractures.

We are far from the pieces in the Dupuytren museum analysed by Dudouyt and which inevitably, since they are pieces from a museum, contain only a part of the truth.

Moreover, Dudouyt was very perplexed how to classify them : of 69 pieces in which he looked for the line of fracture the latter was in doubt in 22, nearly a third of the cases, and the variety in height of the line itself is very deceptive.

Twice the line was 6 mm. above the space.
Eight times it was 10 ,,   ,,   ,,
Twice it was   11 ,,   ,,   ,,
Three times it was 12 ,,   ,,   ,,
Twice it was   13 ,,   ,,   ,,
Once it was   14 ,,   ,,   ,,
Seven times it was 15 ,,   ,,   ,,
Three times it was 18 ,,   ,,   ,,
Twice it was   22 ,,   ,,   ,,
Nine times it was 25 ,,   ,,   ,,

FIG. 72.—FRACTURE OF THE STYLOID PROCESS OF THE RADIUS.

This would suggest two maxima : one at 10 and the other at 20–25 mm.

If we add 26 times the fracture was comminuted and in these pieces the line was difficult to see, because of the multiple exostoses which deformed the primary piece, it will be seen this collection of data has only a feeble value in comparison with the reading of radiograms.

In the main, all this pathological anatomy, whose exactness and the positive qualities are certainly preferable to pathogenic hypothesis, has a real value only so far as it allows of two practical ends : the establishment of a prognosis and the indication for a rational treatment, but excluding these two ends the multiplicity of the forms and of the fragments do not allow of anatomy being taken as a base for classification.

It is much more important to know why and how the function of the wrist is affected by such and such a type which ought to be preserved, and how it can be re-established.

CLASSIFICATION.—This point of view leads us to look at fractures of the lower extremity of the radius according to two types of lesions, the anterior and the posterior.

The anterior type includes two kinds of occurrences of quite different origin : (1) Fracture of the styloid process of the radius without displacement and the simple conchoid fracture of Smith and Lecomte, which is met with in automobilists : (2) Anterior marginal fracture and the fracture of the epiphysis from a fall on the back of the hand.

Their anatomical characteristics are of two kinds : either the styloid process of the radius is alone separated by a line of fracture situated 15 millimetres from the point of the styloid, without any important displacement, or the whole epiphysis is separated from the diaphysis. In this form, the line is generally curvilinear with concavity above : it is the conchoid form of Lecomte. It is not rare to note separation between the two lips of the fracture. The swelling on the back of the hand, so characteristic of the ordinary fracture, is also formed, but has quite special characteristics. Instead of encroaching on the

K

radius as in the fracture of Pouteau-Colles, it is situated on the wrist; the radius forms thus a swelling in front which results in the articular surface of the radius normally looking from below forward being turned either directly below or below and behind.

The flexor tendons are raised, and on reduction it is necessary at first to press back the protruding fragment in front before flexing and adducting the hand. It is important to know these lesions proper to fracture from tearing, because often we have to deal with lesions of this kind when apparently the clinical history of the cases would tend to make us believe the case was one of crushing.

Moreover, as in a fall with hand extended, the hand meets an obstacle, a stone or a pipe, which raises the metacarpals and the fingers, and the fracture of the radius which results will belong to the anterior type. Sometimes the fracture may be mixed, the first stage having torn the anterior lip, the wrist descends and rests on the ground, and the shaft of the radius ends by being crushed in the second stage. We must therefore be eclectic.

Fractures from a fall on the back of the hand are fractures in the position of forced flexion.

Anatomically, they are closely related to those with free hyperextension, but they have, however, characteristics of their own. They vary from simple driving backwards of the anterior lip to complete fracture of the epiphysis by exaggeration of its normal curve.

The driving back of the anterior lip is the anterior marginal fracture of Letenneur: it is a partial fracture: it is accompanied by anterior subluxation of the carpus, so that an anterior prominence formed by the fractured epiphysial portion and by the carpus is observed. The tendons, vessels and nerves become stretched over this prominence as over a bridge. The swelling observed on the back of the hand is formed by the upper fragment of the radius which protrudes above the more or less depressed carpus.

Fracture of the epiphysis from a fall on the back of the hand, the fracture of Goyrand, is characterised by anterior displacement of the fragment. It makes a more or less
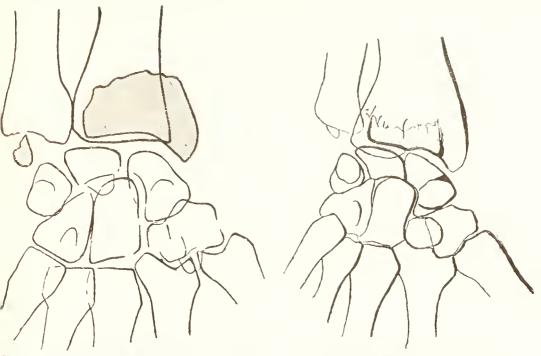
FIG. 73.—ANTERIOR MARGINAL FRACTURE
WITH A LARGE FRAGMENT.

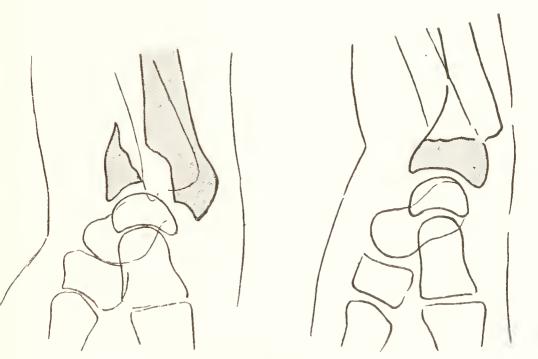ANTERIOR MARGINAL FRACTURE
(Letenneur).

FIG. 74.—GOYRAND'S FRACTURE.

marked protrusion in the palm. The line is distinctly horizontal in the majority of cases. The carpus follows the radial fragment and the swelling on the back is in this case replaced by a protrusion in front. It is not rare to find besides the fractures of the radius, fractures of the scaphoid, posterior radio-carpal luxations, fracture of the os magnum or carpo-metacarpal dislocation; these latter complications are, however, quite exceptional.

The carpus, therefore, shows the part it plays in the production of these fractures. Although it seems in this special type to exercise a milder action than in the posterior type, it is yet incontestable since the turning of the anterior lip or the anterior displacement of the epiphysis in falls with the hand flexed are directly caused by the carpus, and cannot be attributed to laceration.

The posterior type is the more frequent : it is represented by a common classic form, the ordinary Pouteau-Colles fracture, of which the others are only varieties.

The classic fracture of the lower extremity of the radius was first described by Pouteau and then by Colles, and was the purport of the experiments by Dupuytren. Its characteristic is the deformity of the wrist, with a swelling on the back of the hand.

The fractured radial epiphysis ascends more or less high on to the dorsal surface, pulling with it the whole hand, the thumb is inclined to the radial side, the ulna appears luxated posteriorly and there is felt on the anterior part of the wrist the protrusion of the lower extremity of the upper fragment.

The apophyseal part of the radius ascends higher than the internal part, and the bi-styloid line becomes horizontal or even oblique in an opposite direction to the normal.

The styloid process of the ulna is frequently torn off. The wrist is enlarged in the antero-posterior direction, and if looked at side-view the swelling on the back is seen to be formed by the subluxation posteriorly of the carpus which has followed the epiphyseal fragment.

We will not refer to the consideration of the exact site of the line of fracture : we have seen there are two areas

where it is most readily produced, the one at 10, the other at 20 or 25 millimetres above the space.

As to the direction of the line of fracture, it has lost much of its importance since radiography, and theories have yielded to facts. We have seen the difficulty Dudouyt had in determining it from the pieces in the museum : usually we have found it to be horizontal, but slightly oblique below and in front.
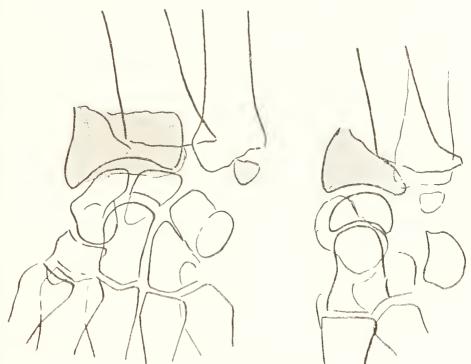

Fig. 75.—Pouteau's Fracture.

Most often the fragments are firmly impacted into each other, the upper fragment penetrating into the lower, and this is more marked externally than internally. The styloid process appears, as a result, distinctly raised and hence the direction of the articular surface is altered : it is turned more externally with resultant displacement of the carpus and of the hand externally, hence the more apparent prominence of the head.

It sometimes happens the lower fragment pivots, the forearm rotating on its longitudinal axis when the hand is held firmly on the ground. This torsion of the fragment

which brings the hand with it gives rise to the separation.
The consequence of it is the loss more or less marked of
the movements of pronation and of supination. It is
therefore important to find it out.

The styloid process of the ulna is usually torn away and
appears in the plates adjoining the internal border of the
radius.

This quite distinct fracture is not as common as we should
expect. By means of radiography we can recognise
extremely various anatomo-pathological forms. The
epiphysis may crack into many fragments and give
rise to the form described by Dupuytren under the name
of stellate fracture. The antero-posterior diameter of the
extremity of the radius is then increased and the radial
deviation of the hand is more marked ; the plates show the
largest fragment answers to the scaphoid. The swelling of
the back is always appreciable. This form differs little
from the classic form, it is the multiplicity of the fragments
which make it of interest and also their origin in the joint,
and this latter condition also makes it serious.

Splintering of the epiphysis shows itself very often by
the presence of two fragments, one corresponding to the
semilunar and one to the scaphoid. The line which
separates them is detached from the articular surface at
the crest of the scaphoid and of the semilunar, thus stamp-
ing the action of these two bones on the glenoid cavity of
the radius. This line takes the form of a T, or a V, or of a
Y, and the varieties can be described by the appearances
observed, but, in reality, the fragments are those of the
semilunar and of the scaphoid, separated by a dentated
division of variable shape. Related to this form, are the
longitudinal fissures of the radius : they are sometimes
the prolongation of the line of separation of the semilunar
and scaphoidal fragments and correspond to this neutral
zone. Sometimes also these fissures are revealed by radio-
graphy under the neighbouring lesions : the shaft of the
radius is separated and fissured longitudinally in this
neutral zone within and without.

Besides these common forms, radiography shows the
frequency of cuneiform fractures. They are related to

FIG. 76.— POUTEAU'S FRACTURE.

the group we have just described. We have just considered the fractures consisting of the semilunar and scaphoidal fragments : here, the fracture is of one of these fragments.
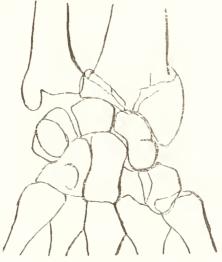

Fig. 77.—Fracture in Y.

The carpal incus has only a local reaction on the radial malleus.

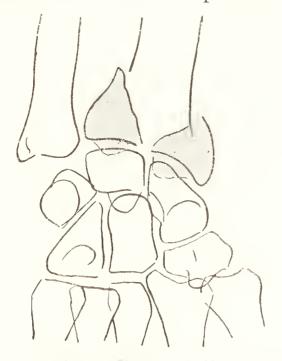The external cuneiform fracture expressed anatomically,

Fig. 78.—Fracture in Y.

consists in the separation of an angular-shaped piece of bone from the apophysis of the radius. The line originates at the level of the crest of the scaphoid and of the semi-
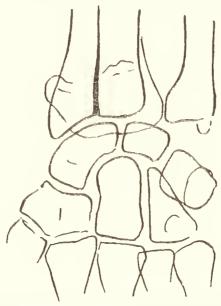

Fig. 79.—Vertical Fissure of the Lower Radial Epiphysis co-existing with a Pouteau's Fracture (Gallois).

lunar sometimes internally, and passes obliquely above and outside. According to the case, the displacement is
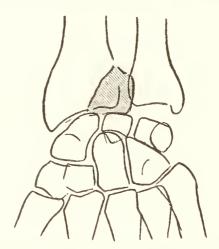

Fig. 80.—Internal Cuneiform Fracture.

more or less pronounced from a simple notch up to pushing upwards of the apophysis with penetration of the diaphysis and following a true blow from the shaft of the radius.

Internal cuneiform fracture is more rare, but more serious : it affects the radial portion in connection with the semilunar : the line arises at the crest of the scaphoid and of the semilunar and ascends more or less high above
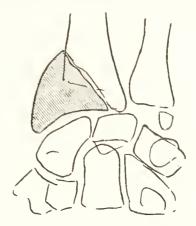

FIG. 81.—EXTERNAL CUNEIFORM FRACTURE.

the sigmoid cavity. The fragment is generally pushed back above and becomes impacted between the radius and the ulna, preventing the play of these two bones by destroying their inferior articular surface. We shall have to
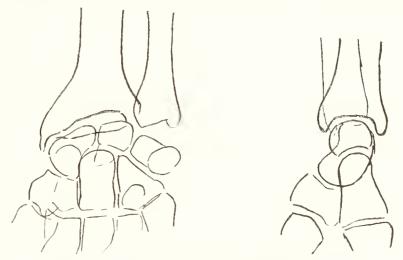

FIG. 82.—IMPACTED FRACTURE WITH EXPANSION.

insist on the necessity of perfect reduction of this serious form, in order to avoid the consequences of this fracture. The fracture of a spur of bone or a fracture with expansion is nothing but partial impaction of one or of many bones of

the carpal condyle into the thickness of the radial epiphysis.
Sometimes it is the scaphoid which, straightened by
extension of the forearm on the hand, penetrates into
the apophysis and a bed is excavated ; sometimes the two
bones, the scaphoid and the semilunar, open a passage into
the epiphysis and cause it to bulge into anterior and
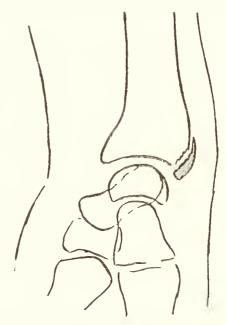posterior lips.   These forms were unknown before radio-

FIG. 84.—POSTERIOR MARGINAL FRACTURE.

graphy : they would have particularly astonished the
obstinate partisans of the theory of laceration.

   In these fractures, the antero-posterior thickness of the
wrist and the nearly complete abolition of the movements of
the hand form the principal characteristics.   Among the
fractures of the anterior type we have the anterior mar-
ginal, and in the posterior type the posterior marginal
fractures.   Anatomically, they only betray their existence
by slight destruction, such as notching of the border of
the scaphoid, also more or less extensive separation of the
posterior radial lip, and as these lesions show often the
imprint of their origin, the carpal condyle is fixed under
this turned-up lip, giving rise to complete displacement or
to a characteristic luxation.

   In the child, the low fracture analogous to that of the

FIG. 83.—Impacted Fracture with a Spur of Bone, with Dislocation.

adult is exceptional : the high fracture 4 to 5 centimetres above the space is the one ordinarily seen and shows itself under the form of infraction rather than a true fracture, and the resultant dorsal protrusion is different from the swelling on the back in Pouteau's fracture. The fragments become more or less impacted : we will not go into this point.

Besides this form, separation close to the epiphysis is met with, with the characters common to this kind of lesion : incomplete or complete separation with displacement of the epiphysis. In addition, there is frequently observed

FIG. 85.—FRACTURE OF THE
HEAD OF THE ULNA.

FIG. 86.—ISOLATED FRACTURE
OF THE ULNA.

in young people separation also of the epiphysis of the ulna.

The principal characteristic of these lesions in the child is that they remain extra-articular.

Fracture of the lower extremity of the radius is often associated with fracture of the carpus.

The wrist forms a mass whose centre is the radio-carpal articulation : but we have seen fractures are due to sudden and violent contact of the anti-brachial and of the carpal segment, one acting like a malleus and the other as an incus, hence the variety of the combinations. The most frequent is fracture of the scaphoid : it is, moreover, the piece of the incus which bears usually the greater part of the blow. Next in order are dislocations between the scaphoid and the semilunar, and fractures and dislocations

of the semilunar and, more rarely still, fractures of the os magnum and of the cuneiform. These affections of the carpus are more grave generally than fracture of the radius and bring the latter into the second degree. Concomitant fracture of the styloid process of the ulna is not a serious complication. This process intimately connected with the triangular ligament is broken as a result of the impaction of the carpus on the triangular ligament, and is sometimes lodged in the radio-ulnar articulation. Fracture of the head of the ulna is rarely met with except in young subjects. For a fall on the palm of the hand to produce it, a marked sinking of the carpus or of the radial epiphysis is required, hence its rarity.

METHOD OF PRODUCTION. — The examination of the figures, more even than their description, shows the connections uniting the different anatomo-pathological forms and their close relationship. An identical cause is to be expected from neighbouring lesions and we must not reject expressed opinions without examination. Our views must not be narrow. We shall find, if the majority of fractures result from crushing, laceration is also seen. The fault is too much generalisation.

Since radiography, and especially since the physiology of the carpus have become known, the theories of Lecomte, as e.g. that of flexion, only apply to special occurrences. To understand the method of production of these fractures, and here we have at all events in view the classic fracture of Pouteau, we must recall the structure of the lower extremity of the radius. The compact tissue which forms the sheath of the diaphysis becomes thinned at the epiphysis, and at 15 millimetres, from the space, it exists only as thin lamellæ, hence the fragility of the epiphysis. In addition, there exists an anterior curve on the anterior surface, and the summit of this curve is 3 centimetres above the space, forming in this way a weak spot ; it also must be noted the posterior radial lip descends lower than the anterior : in these facts we have the elements which well explain the traumatic conditions to be considered.

FIG. 57. FRACTURE BY INFRACTION.

The method of transmission of the force has been discussed for a long time. Lecomte, Lopès and Poirier are the defenders of the indirect transmission of the ulna on to the radius, by means of the interosseous ligament. These theories are based on incorrect anatomical data.

I have done justice to these theories in Gallois' thesis. Examination of the frozen pieces, the researches made with Barjon on the elbow joint, and experimentation, demonstrated the transmission was direct, which is, moreover, no more discussed to-day.

The force represented by the weight of the body is transmitted by the rigid levers of the forearm to the metacarpal mass and thence directly to the ground, which forms the point of resistance. We have shown the thenar eminence descends lower than the hypothenar and is, thus, more exposed to injuries, and also that the scaphoid which forms the chief osseous structure is, therefore, the agent of direct transmission of the force of the radius to the ground, whilst the less prominent hypothenar eminence only secondarily enters into play.

If we consider how in falling the natural movement of protection is to bring the palm of the hand forwards, we shall see the most frequent position in falling is that in which the hand is placed on the ground, the forearm forming with it an angle of 45 degrees.

Having recalled these general data, we can follow as in a diagram the explanation of the lesions which pathological anatomy has revealed to us. In supported extension we have seen the first row overhangs the second like an arch, the semilunar occupying the summit, and the scaphoid the external pillar. The scaphoid is in addition, as the result of its vertical position, a resistant organ fixed between the radius and the ground. It cannot escape and slip away from pressure as the semilunar often does : it is jammed, and the only movement it can execute squeezes it still more under the radius. It can besides only tilt posteriorly from the time that its palmar apophysis has become violently in contact with the ground. The scaphoid is then compelled to bear the whole shock if the hand be extended on falling, especially if, as a result of in-

equality of the ground and from inclination to the radial
side, it becomes the summit of the carpus.

These bones, moreover, divide the force and distribute
it over the carpus, but they react vigorously in their turn
against the radius and it is understandable how the
epiphysis, which is a place of least resistance, breaks. The
epiphyseal fragment is inevitably pushed upwards and
behind, as a result of the position of the scaphoid, because
it is, moreover, this bone which forms the essential part
of the anvil on which the radial epipohysis is broken.

According to the violence of the shock, there will be
more or less impaction of the fragments.

The rupture of the epiphysis, the displacement of the
fragment posteriorly and its impaction are due to the
carpus and to the carpus only. The swelling on the back
of the hand is due to the scaphoid. This theory, which I
enunciated in 1898, has the support of not only physiology,
but also of pathology and of experiment. Pathological
anatomy shows the tilting of the scaphoid which accom-
panies the posterior displacement of the fragment : it
shows also the destruction of which the scaphoid is often
sometimes the victim, as a result of *contre-coup*.

Experiment shows it is possible to control the facts
enunciated and to destroy the objections which can be
raised, e.g. regarding the anterior ligament of the carpus,
of which we do not deny the value as a means of keeping
the carpus in position, but not as the exciting cause of the
classic fracture we are considering.

We have seen the commonest position on falling : we
shall study the others in turn and show the rôle of the car-
pus in the production of the different anatomo-pathological
forms.

Hyperextension gives more resistance to the osseous
trabeculæ of the radius and assists in the production of
fractures of the carpus. The bend to the radial side offers
more purchase to the direct reactions of the scaphoid and
explains the external cuneiform fracture.

Inclination to the ulnar side facilitates pressure on the
ulna, and makes it easier to understand internal cuneiform
fractures.

It is sufficient to vary the points of application of the force to see the method of production of the most different types of fractures in extension of the hand, and to note, everywhere and always, the carpus makes its mark on the radial malleus.

In fractures from a fall on the back of the hand, the mechanism is simpler. We have shown the anatomical lesions are marginal or epiphyseal fractures with anterior displacement. Physiology has made us anticipate these two varieties, since in supported flexion the anterior border of the radius comes in contact with the carpus. Marginal fracture then becomes almost certain, if the radius be forcibly thrown forwards : complete fracture of the epiphysis occurs also as a result of a violent injury. Experiment supports these views. It completes them also in a certain degree, since it shows the concomitant lesions of the bones of the carpus. The production of sinking alone explains these lesions, and, if the carpus play here only a passive part, it is, nevertheless, it which produces the anatomical appearance.

In this way, and this is the essential fact we have maintained since 1898, fractures result from a fall on the palm or on the back of the hand, and the sinking observed is due to the carpus.

The wrist is a mass and we must not concentrate our attention on one part, but look on the region as a whole. Every fracture of the lower end of the radius recoils on the carpal condyle.

There remain fractures with free hyperextension. Here the mechanism is that of *arrachement* : it is sufficient to refer to physiology to see, when the hand is forcibly hyperextended, the anterior radio-carpal ligament is stretched to the maximum and contact of the posterior lip of the radius with the os magnum increases this tension still more. Experimentally, we have reproduced these lesions and the consideration of them will be found in Gallois' thesis.

CLINICAL EXAMINATION.—The clinical signs of the classical fracture of the lower extremity of the radius

can be summed up in a few words : pain, loss of func-
tion, more or less late ecchymosis, deformity by a
swelling on the back of the hand, transverse enlarge-
ment, lateral displacements of the hand and prominence
of the head of the ulna.

These signs are usually so marked that the diagnosis
can be made from a distance.

The swelling on the back of the hand deserves, however,
more than a passing notice. It is sufficient to refer to the
plates, side view, to see it is formed by the dorsal protrusion
of the lower fragment, bringing the carpus and the hand
with it. The index finger palpating the dorsal surface
of the forearm alights on the lower fragment and, passing
on to the palmar surface, meets also at the same level a
prominence formed by the lower extremity of the fractured
diaphysis.

But this classic deformity is sometimes replaced by
malformations which thrust themselves upon us on a
rapid examination. In anterior marginal fractures and
also in those produced by a fall on the back of the hand,
the wrist is deformed, there is an apparent swelling on the
back, when in reality there is an opposite lesion ; the
carpus has followed the fragment in its anterior displace-
ment and the so-called swelling on the back is only the
depression made by this displacement. It is, in reality
the dorsal extremity of the radius which is prominent and
not the fragment : the general appearance is that of a
swelling in front and not on the back of the hand. The
classic fracture is not so often met with as the old authors
supposed, and the clinical signs have little by little lost
their value. It can be said there always exist some exact
signs, but the majority are modified and altered.

The inclination of the hand to the radial side is sometimes
absent, and is even in some internal cuneiform fractures
changed to a flexion to the ulnar side. The transverse
enlargement may be wanting in marginal fractures.

Protrusion of the head of the ulna is not seen in fractures
without displacement.

Pain, if usually acute, is quite able to be borne by old
people.

Loss of function is not always complete. Diagnosis without radiography is only possible in some forms, but it is always useful because it determines the destruction of the bone that palpation has only surmised.

Radiography is, in addition, necessary in order to recognise the state of the carpus, and on this the prognosis of the fracture depends.

To recognise a fracture of the lower extremity of the radius is not, moreover, sufficient, it is necessary to know the exact variety : if it be articular or not, if the carpus be the site of a sprain, or if the scaphoid and semilunar be dislocated, or if one of its bones be broken. An exact diagnosis can only be made by radiography.

There are many clinical landmarks which can lead us on the way, but they are difficult to detect. They are :

(1) The obliquity of the line between the styloid processes.
(2) The exploration of the anatomical snuff-box.
(3) The examination of the os magnum.
(4) The examination of the nervous disturbances.

If the normal obliquity between the two styloid processes be preserved, it is rare for the radius to be broken. There is an exception in fracture of the semilunar type of fractures or the anterior marginal not extending to the point of the styloid process.

If the obliquity be not preserved, examination will show a notch corresponding to the site of the fracture : it must be sought for and found. The bi-styloid line is the boundary between the carpus and the arm.

The obliquity being preserved, and the examination of the lower end of the radius revealing nothing abnormal, we must examine the carpus. Examination of the anatomical snuff-box ought to be made in the first place. It may reveal the presence of an abnormal protrusion, when the scaphoid is broken or straightened from a dislocation. The extent of the snuff-box is diminished by ascent of the first metacarpal bone in cases of fracture or dislocation of the scaphoid.

Examination of the os magnum can lead us on the way

L

of an exact diagnosis : if we follow from the index finger the dorsal surface of the third metacarpal bone, we reach the os magnum, an important landmark of the carpus. At this moment, if we move the hand slightly, the semi-lunar is found to be replaced by a depression ; it has left its normal position. On seizing the wrist between the thumb and the index finger, displacement of this bone can be generally noted. This sign, in conjunction with those resulting from exploration of the carpus, will make us think of a luxation or of a fracture of the semilunar.

The sensory disturbances are invaluable indications of the lesions of the carpus. I have never found them absent.

Lesions of the cuneiform, of the unciform and rarely of the semilunar give rise to disturbances of the ulna nerve : lesions of the semilunar, of the os magnum and exception-ally of the scaphoid affect the median nerve. But, in spite of a well-conducted and minute examination, mistakes can be made, and radiography is alone capable of making an exact diagnosis, and also determining the prognosis of these fractures.

PROGNOSIS.—The prognosis of fractures of the lower extremity of the radius varies according to the anatomo-pathological forms. Generally, it is good, but apart from the forms which may be said to cure themselves, there are those which are serious from the beginning and others which become so. The factors causing gravity in these fractures are numerous and ought to be mentioned.

The one concern the patient himself, the others the anatomical form and the nervous disturbances.

In the first group, the general state is alone the cause. The diabetic, the tuberculous, the tabetic, and patients with acute gonorrhœa or other analogous affections, are subject to complications which change simple fracture into serious lesions, often requiring prolonged treatment.

Women at the time of the menopause, after a slight fracture, may suffer from trophic troubles with neuritis and decalcification of the bones. The second group in-cludes : (1) certain isolated fractures and (2) combined lesions of the carpus and of the radius.

The deformity from the swelling on the back, even if very marked, is not in itself a serious factor : it is the antero-posterior displacement, which is often less visible, which is the more grave from a functional point of view.

Lateral displacement is not of great importance. The true cause of the seriousness is the alteration of the articular surface which is met with in certain fractures from crushing or from laceration. Fractures into two fragments, the semilunar and the scaphoidal, and the marginal fractures are frequently accompanied by arthritis as well as all those which alter the articular surface.

Impacted fracture with expansion or of a spur sometimes produce anchylosis of the radius and of the carpus.

Internal cuneiform fractures or fractures of the sigmoid cavity are serious, because they hinder pronation and supination.

Extra-articular fractures may be associated with loss of pronation and of supination, as a result of a change of the axis between the diaphysis and the fractured epiphysis, the latter being more or less markedly separated.

The concomitant lesions of the carpus which form a serious factor consist in alterations in form and position of the bones of the first row and in anchylosis between the radius and the carpus.

The commonest and the most necessary to know is sprain.

The scaphoid which is normally spread out in an oblique direction, moulded, so to speak, on the os magnum, changes its appearance : radiograms show it coiled on itself and globular : in other cases, it projects its shadow over the middle part of the os magnum and then a clear space appears in the sinus of the angle formed by the scaphoid and the semilunar.

The semilunar is carried back to the ulnar side and no longer fits into the head of the os magnum. Its anterior lip is thrown on to the plate and shows an anterior tilting.

This sprain of the scaphoid and of the semilunar is the real complication of fractures of the lower extremity of the radius, for fractures of the carpus or their luxation have

very special symptoms and appearances, and leave
fracture of the radius in the background. Lesions of the
carpal condyle can be accompanied with anchylosis, i.e.
anchylosis between the scaphoid and the radius, or between
the latter and the semilunar, or again between the radius
and these two bones. These radio-carpal synostoses are
especially met with where the carpal lesions have not suffici-
ently drawn one's attention from the beginning. Once
they exist they are visible and easy to detect. The trophic
disturbances in the bones are one of the most important
and serious factors. They appear a short time after the
accident and betray themselves by acute pain and by loss
of function. By radiography, the bone is seen to be
decalcified, and this can attain such a degree as is barely
revealed by the X-rays.

The osseous trabeculisation has disappeared at the
epiphysis, in the carpus and often in the metacarpal
bones. The trophic troubles, usually, only yield to an
operation which frees the branches of the nerves, and when
they are cured, fine trabeculæ are seen to reform : it is a
true picture of the course of pressure and of traction so well
studied by Wolf. By degrees, the bone becomes con-
solidated and the function returns.

TREATMENT.—Fractures of the lower extremity of the
radius have served as a base of discussion for the partisans
of mobilisation and of immobilisation, the one demanding
reduction and immobilisation of the fracture, and the others
maintaining massage is sufficient and immobilisation is
dangerous. These simple ideas could hold good before
radiography : they seem now void of interest. How are
we to compare lesions so different from each other,
although offering at one examination, even perfectly
conducted, a similar appearance ?

How are we to compare intra-articular with extra-
articular fractures or lacerations with depressions ? How
can we put into the same class fractures with and without
displacement, fractures close to the epiphysis in children
with cracking of the bone so frequent in aged persons ?
The varieties of fracture are numerous and offer a vast

field for the therapeutic art : they require a judicious selection of the means to be adopted.

To tell the truth, what makes this question so difficult is that many fractures, at least 6 out of 10, are perfectly cured by any kind of and also without treatment. How many sprains of the wrist are nothing else but fractures, and yet, after three weeks' immobilisation with a bandage, the patient attends to his customary work ! How many times has not radiography shown before and after treatment the procedures employed have not sensibly destroyed or modified the impaction of the fragments, and the classic position in flexion and adduction of the hand has deluded us that reduction has taken place when in reality it was not so ?

It can therefore be stated cure is then made spontaneously by a perfect functional adaptation and accommodation, due to the fact the movements of the mid-carpal articulation complete those of the radio-carpal. Perfect reduction, not appearing essential, has been abandoned and the treatment generally neglected.

There yet always remain a certain number of cases which are not cured, or, if so, badly, and which would have benefited by rational treatment, and it is certain for the others æsthetics do not injure the function. We shall distinguish two great classes, intra-articular and extra-articular fractures, and in these two classes two varieties, fractures with and without displacement, reserving to ourselves to return later to the complications resulting from fractures of the neighbouring bones. Extra-articular fracture with displacement is common : it is obvious, and the difficulty lies not in recognising but in treating it.

The broken mass of the epiphysis protrudes on the dorsal surface, bringing the whole hand with it, forming the swelling on the back and inclining the hand to the radial border, the head of the ulna being under the skin.

Impaction is almost constant. It is a providential occurrence for M. Lucas Championnière and his pupils, who rely on mobilisation and massage. It is true these fractures usually cure themselves, and the subsequent result is a good one. Many prefer to reduce them, and I am strongly with them.

Early mobilisation may perfectly re-establish the function, and it is sufficient to examine a great number of workers to see that many have had untreated fractures of the radius and yet can perform very laborious manual labour. But if the function have returned, the deformity exists.

It is not rare to find certain of these patients have lost to a great extent, and sometimes completely, pronation and supination. This loss is due to the radial fragment pivoting on itself and bringing the hand with it, so that the hand is no longer in the axis of the radius, but within or outside it. Reduction avoids these two dangers : it should therefore be performed and carried out as exactly as possible.

How are we to reduce the fracture ? We will indicate two methods. It is necessary to spare the patient too acute pain, and to make him inhale a little ethylchloride, and directly anæsthesia has been produced to act vigorously and quickly. The forearm should rest on a table with the hand out of the perpendicular. The surgeon should place himself near the patient's shoulder, and seize the wrist with his whole hand. The two thumbs on the dorsal surface should seek for the prominence of the fragment, catch hold of it and push it forward. They should bear on it many times, depress it and finally place it in the radial axis. This brings about forcible flattening, requiring sometimes the whole weight of the body, and ought to be stopped only after complete reduction. It is, moreover, only a question of a few moments. The radial deviation is no trouble : it is quite surprising when the swelling has been crushed, to see the hand return spontaneously to its normal position, and the prominence of the ulna disappear.

In order to obtain reduction, it is necessary to employ great manual force, and I have invented an adaptable pair of forceps for this purpose.

It consists of two long branches, bent at a right angle and ending in flat jaws 2 centimetres broad. The jaws are provided with leather and rubber to prevent alteration of the soft parts. The joint is made of elastic so as to

avoid too great pressure. A space of 2 centimetres exists between the jaws, even when closed, in order always to preserve the integrity of the bone.

Reduction having been obtained, a small plaster apparatus, for preference on the dorsal surface of the wrist and of the forearm, should immobilise the fracture for 12 to 15 days at the most. The plaster is then to be removed each day, and slow and progressive movements carried out, with local hot baths and slight massage : after that the plaster is to be replaced. A cure is generally obtained after 30 to 40 days. If the ecchymosis and swelling be very marked the plaster should be removed the first few days and massage and hot local baths applied.

Fractures close to the epiphysis in children should be reduced in the same way, but great care must be taken during the forced manipulations and immobilisation prolonged longer than in adults, i.e. certainly 15 to 20 days. Massage ought to be forbidden and passive mobilisation take its place. By following these directions, exuberant callus is avoided. The formation of new bone is, moreover, in children exaggerated by massage and by forced movement.

Reduction ought to be carried out with care, but the hand ought not to be flexed forcibly, with marked inclination to the ulnar side exaggerating Volkmann's method. The epiphysis would be dragged upon and ultimately functional disturbance of pronation would be the result.

Extra-articular fractures without displacement are generally fractures from tearing met with in automobilists, or fractures from forced flexion. The deformity is rather a swelling on the front than on the back. The treatment hardly differs from fractures with prominent displacement ; reduction ought to be made with care, and immobilisation should be prolonged for 18 days before beginning treatment by local baths and by massage.

Intra-articular fractures require about the same treatment in all cases. Reduction ought to be procured by traction on the hand, at the same time as strong pressure flattens the fragments. The adaptable forceps here also are of great service.

What differentiates intra-articular fractures from those of the first group is the length of immobilisation. The wrist ought to be moved very early, 5 to 6 days, after reduction. Between massage, which ought at the beginning to be very short, the hand should be replaced in the plaster splint.

Cure often takes a long time, and some signs of arthritis, to which we will return, may be produced.

The duration of the treatment in marginal fractures and those in T is long, and may reach 2 to 3 months. Internal lateral fracture requires very careful treatment, and reduction should be controlled very carefully by radiography. It is necessary to endeavour very early to re-establish the lower inferior radio-ulnar joint.

Articular fractures with displacement are more suitable to massage and to movement than immobilisation.

From these details we see the treatment of fractures of the lower extremity of the radius ought to prompt us to know especially the anatomical forms.

There are some complications of fracture which deserve to be noted : œdema, nervous disturbances and separation of the fragments.

Œdema depends on the general or on the local state. The age and the sex are important. It is more frequent in patients over 40 years of age and in women after the menopause. The treatment consists chiefly in slight massage, very hot local baths or the use of feeble continuous currents, not more than 5 to 8 milliampères.

Œdema depending on the local condition is due to a too tightly applied apparatus, when the wrist is already too markedly swollen. This question compels us to fix the time when the plaster ought to be applied. I consider reduction should be made immediately after the accident, and the plaster applied directly afterwards. It is the best method for obtaining good reduction and avoiding œdema. If the fracture be already many days old and œdema be present, it is better to wait for it to disappear, at least partially, and during this time to apply a slightly tight cotton-wool bandage.

The treatment of compression of the nerves consists in early reduction, and it is unnecessary to insist upon it.

Trophic nervous disturbances are serious complications. Sometimes in aged people the bone is seen to decalcify and become fatty and soft, and local pains at first radiate up the arm. The treatment is that of neuritis ; some months may pass before cure supervenes.

Separation of the fragments ought to be avoided if reduction be correctly carried out, but with a change in the axis between the diaphysis and the fractured epiphysis, preventing pronation and supination, instrumental or surgical osteoclasis may be necessary to replace the two fragments into their true axis.

In combined fractures, what is important is to make the diagnosis and not to take fractures of the scaphoid or dislocations for sprains. In fractures of the radius, with a lesion of the carpus, the latter is the more difficult to treat, and it is on that the whole of one's attention should be concentrated. We have, gradually, in our description of the different fractures of the carpal bones, sufficiently insisted on their treatment, and we need not again refer to it.

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INDEX